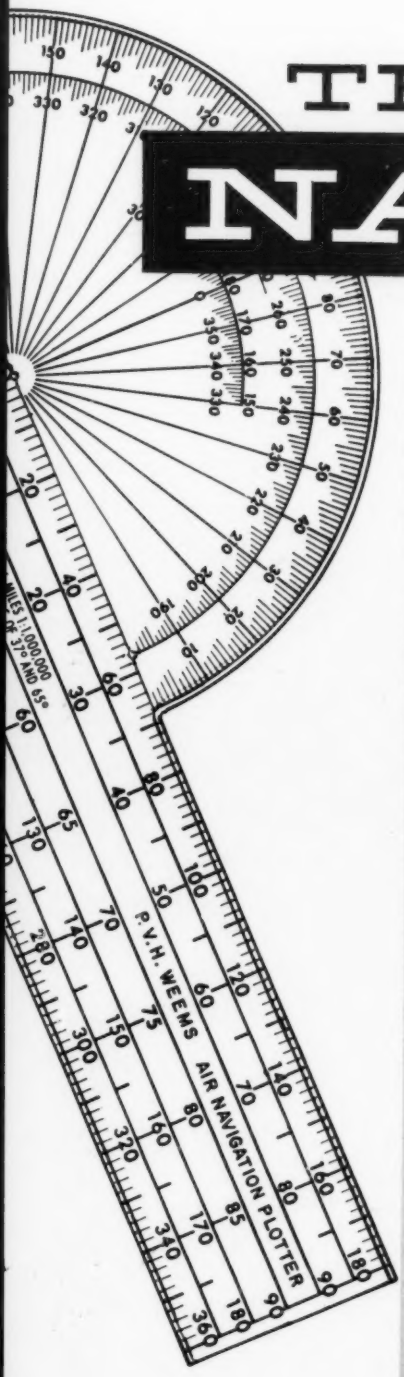
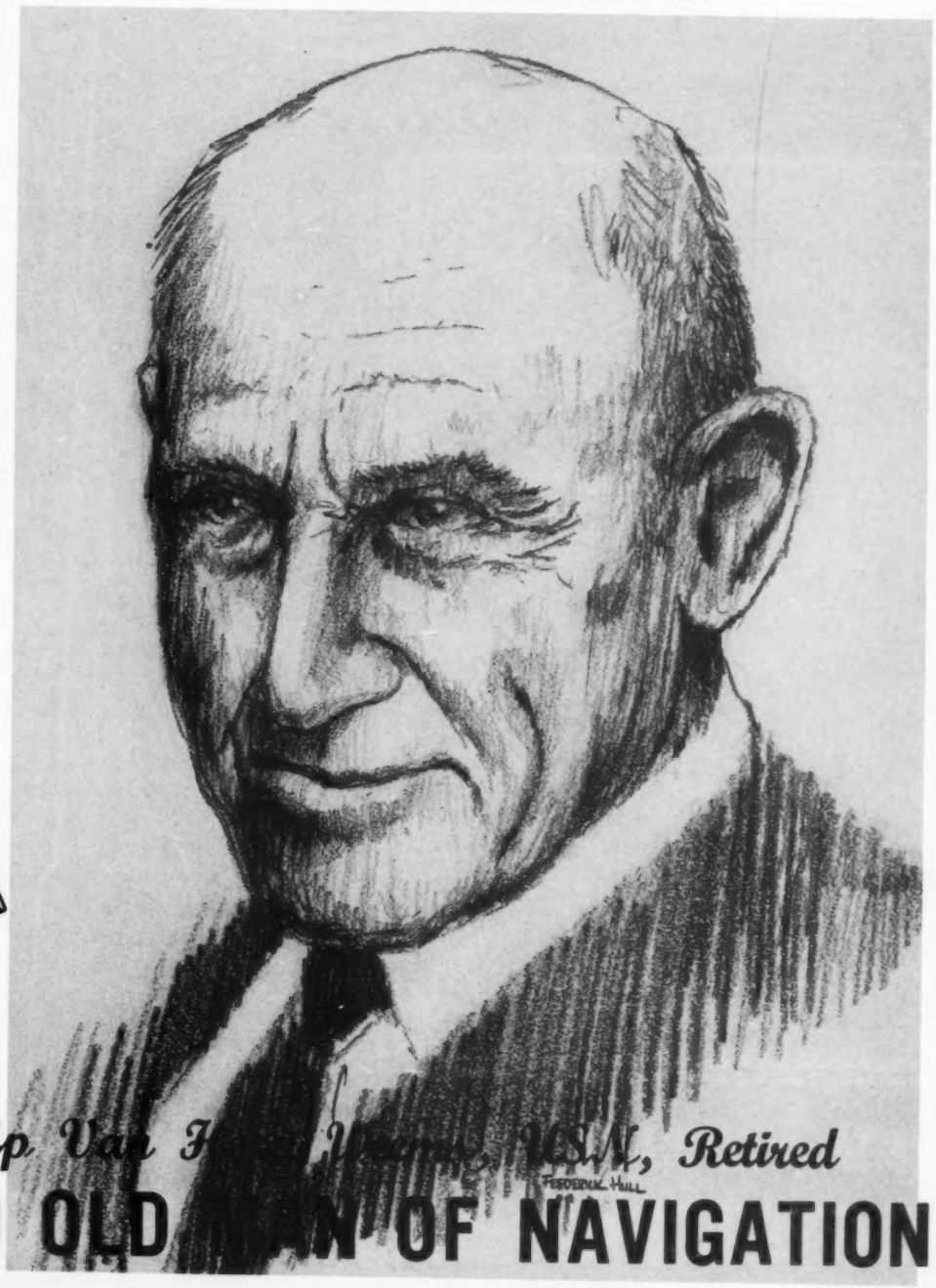
THE NAVIGATOR

AFRP 50-3, Volume XXV, Number 2, Summer 1978





Captain Philip Van F[illegible] USN, Retired

THE GRAND OLD [illegible]N OF NAVIGATION

NAV OF NOTE

The commander of the 481st Tactical Fighter Training Squadron, Lieutenant Colonel Ray Reed, was the third Air Force navigator selected to command a tactical fighter squadron. He discussed his present job, his background, and the Air Force during a recent interview.

"Perhaps the association with a group of young, physically fit people is the main reason for my Air Force career. That's what fighter squadrons are made up of—well-conditioned young men. In addition, the idea of flying and of assignments to other countries clinched this career for me."

Ray Reed was born and reared in Ft. Morgan, Colorado. A 1957 graduate of Colorado State University with a Bachelor of Science degree in Civil Engineering, he joined the Air Force the following year. He received his navigator rating in October 1958 at Harlingen AFB, Texas, and completed advanced navigator-bombardier training the following June at Mather AFB, California.

A Yokota Air Base RB-66 squadron was Colonel Reed's first operational unit.

"I arrived at Yokota in October of 1959," the colonel said. "The unit was disbanded the following year, and I ferried two of the aircraft from Japan to the United States. That was the highlight of my RB-66 experience. By today's standards, our navigational systems were primitive and not as reliable. When we got to the United States we were sufficiently far off course to be 'welcomed' by the Air Defense Command interceptors."

Navigational duties with the 6091st Tactical Reconnaissance Squadron followed, with Colonel Reed flying in RB-50s and RC-130s. The colonel added C-54 and C-97 experience to his career in 1962. Returning to the United States in 1963, Colonel Reed became a navigation instructor in the T-29 at Connally AFB, Texas. When Connally closed in 1965, he continued T-29 instructor duty at Mather AFB.

In 1966, Colonel Reed joined an RF-4C unit at Bergstrom AFB, Texas, and later went to Southeast Asia with the unit. Based at Udorn RTAFB Thailand, he flew 100 missions over North Vietnam.

"Southeast Asia reconnaissance missions were interesting because they virtually were run by the navigator. It was my job to determine the proper course, altitude, and speed and make all the computations for photography. The aircraft commander's responsibility was to fly the proper course, altitude, and speed.

"After that I joined an F-4D organization at Bitburg AFB, Germany. It was less of a personal challenge, as it was primarily an aircraft commander's bombing mission.

"During my tour at Bitburg, however, I spent two and a half years as squadron scheduling officer. It was in that position that I learned all the things involved with getting aircraft airborne and getting missions accomplished—the 'whole picture' of the fighter operations business."

In August 1972, Colonel Reed was assigned to his present duty station, Cannon AFB, New Mexico. This assignment introduced him to the F-111D.

"In the F-111, and especially the D model, there's a combination of bombing and navigation duties. There are an awful lot more responsibilities for a navigator in this airplane. The weapons system officer's basic job is to keep all the navigation and bombing systems going, because the more systems you have in operation, the more accurately the aircraft will operate."

At Cannon, Colonel Reed assumed command of the 481st Tactical Fighter Training Squadron in June 1977.

"During my three and one-half years as an ATC instructor, I learned a lot about the instructor/student relationship," the colonel said. "I learned what sorts of things help the students along and what keeps them content. So, that former ATC experience lends itself extremely well to this job, commander of a training squadron.

"This particular program is probably the toughest one I've ever been associated with, in terms of its technical aspects. The avionics involved are quite advanced. Therefore, the first two months of our training program are exceptionally heavy in academic studies."

During his career, Colonel Reed has flown in nine different Air Force aircraft. The most sophisticated of them is the F-111D. But his present job has given him an association with still another advanced aircraft, the European Tornado.

"We had four Luftwaffe Tornado test crews here for three weeks last year to check out the F-111D's avionics, terrain-following radar, and other advanced equipment. The association was a natural one—the Tornado is a swing-wing aircraft with a potential for multi-role employment, like the F-111D. The German aircrews were attached to the 481st while they were here, and the arrangement was very informative and beneficial for both nationalities."

Colonel Reed's awards and decorations include the Distinguished Flying Cross, the Air Medal with 13 oak leaf clusters, the Combat Readiness Medal with three oak leaf clusters, and the Vietnamese Service Medal. He is married to the former Janice Ann Warren of Waco, Texas. They have four children, Shauna, Craig, Kari, and Kirsti.

FROM THE EDITOR

THE NAVIGATOR magazine seems to be a lightning rod for thoughtful comments about the art, science and career of navigation. We are pleased to report that we have received many suggestions indicating a sincere desire to further our professionalism. These include the Institute of Navigation's interest in reestablishing a chapter at Mather and other bases and a correspondent movement toward a professional/fraternal organization similar to the Navigator Association of the the early 1970s. THE NAVIGATOR stands ready to assist these efforts in any way possible. We urge you to share your ideas on this subject by writing to the magazine.

Many sharp-eyed navigators have written about the production error in the article "Celestial Techniques" in our Spring 1978 edition. Please, when adjusting a celestial LOP for an early or late shot, move it 15 minutes of *longitude* for each minute off scheduled shot time. The author, Captain Jay Weiss, of 32TAS/DOV, Little Rock AFB, knew that all along, and now our typewriter knows it too.

A last note—send articles. Send them through your local Office of Information for policy and security review. We hope you enjoy this issue. The continued value of THE NAVIGATOR depends on the flow of properly cleared articles such as we have always received. Keep up the good work!

TO THE EDITOR

Dear Sir,

I am writing in the hope you can assist me with my future plans.

Next year I will graduate from college and I have decided to enter the Air Force. Like most young men, my eyes were set on being a pilot. However, one day while at Selfridge ANGB, I was given a copy of "THE NAVIGATOR." After reading it, my mind was changed about being a pilot and my interest stimulated in navigation.

At any rate, I am hoping to find any back issues of THE NAVIGATOR and any information on navigator training. Anything you can send me would be appreciated. I thank you for your time and effort.

Jim Hockenberry
23466 Barfield
Farmington Hills, MI 48024

Editor's Note: In the following letter Captain Gary C. Eickmeier critiques the original article by Captain Patrick L. Campbell. Captain Campbell had argued that selection of an assumed position and shooting sequence can induce errors in celestial work. We think a careful reading will reveal that both Captains Campbell and Eickmeier have an excellent grasp of celestial theory. Their argument is not new, but the question is, what shooting schedule do you use?

Dear Editor,

"Choosing an Assumed Position," in the Summer 1977 issue of THE NAVIGATOR, is based on a couple of wrong assumptions, and the solution to the problem it introduces causes more trouble than is necessary for celestial accuracy.

In the example problem, motion of the observer "error" is blamed for the lion's share of the alleged 22 nm error in the LOP. The fact is, a wrong Zn cannot produce error in motion of the observer. Motion of the observer is nothing but a mathematical way of moving LOPs based on relative Zn. If the motion is based on the same Zn used in plotting the LOP, then it results in adjusting the LOP to fix time just as accurately as if you had done it manually with plotter and dividers. Motion of the observer is not the problem.

To find out just what the problem is and how much error there would be, I drew the example on a chart and plotted the LOPs two different ways. In the example, we are flying on a track of 090 at 45°N at a groundspeed of 510K. A precomp for

(continued on page 12)

THE NAVIGATOR

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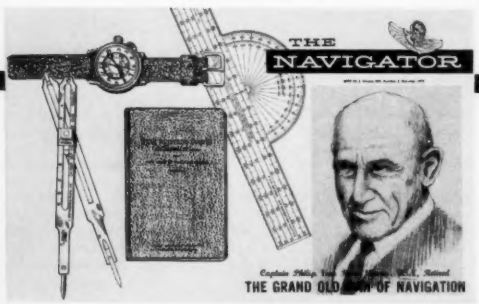

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Captain P. V. H. Weems is pictured on the cover with some of his contributions to navigation—the famous Weems Plotter, the second-setting watch, time/distance dividers, and the Star Altitude Curves book. An instructor pilot describes T-37 training in "What's a Tweet?" on page 16, and a reprint of the rib-tickling "Anyone Can Navigate" is on page 24.

The Grand Old Man of Navigation

Mr G. D. DUNLAP
Dunlap Enterprises, Inc
Annapolis, MD

Can an orphaned country boy from the remote hills of Tennessee succeed at the Naval Academy and in the modern scientific world? Living proof that he can is illustrated by Captain Philip Van Horn Weems, USN, Retired. As one of seven orphaned kids doggedly holding on to their family farm, Captain Weems received only a very limited formal education. Then at 17 years of age, he entered prep school, hoping to pass the Naval Academy entrance exam. Now at 88, he likes to reminisce, saying he was fortunate to have that hard work and play, farm background. His strength and stamina enabled him to letter in football (an all-American selection at center), crew and wrestling with such commanding performances that he was awarded the Academy's sports "sword" for excellence in athletics. His continuing desire for physical excellence undoubtedly has contributed to his long life and good health. In 1920, already eight years out of the Academy, he was a member of the US Olympic wrestling team at Antwerp.

His background also directly influenced his lifelong will to succeed. This characteristic has been admired by many but was often frustrating to those closely associated with him. His philosophy of "what man can conceive, man can achieve" made him refuse to accept a negative answer to any dream. Sometimes his ideas seemed so far out that some of us wanted to ignore them, but his batting average was always high. Although occasionally so far ahead of his time that proper technology was not available, he was right far more often than most mortals.

In true Horatio Alger style, this physically rugged, deeply religious, honest, and sometimes stubborn farm boy was to receive many of the world's most prestigious navigation and scientific achievement awards. Included among these are the Gold Medal from the Aero Club of France (for his first book on Air Navigation in 1932), a British award from the Royal Society of Arts (for development of the second-setting watch), the prized Magellanic Premium (Gold Medal) from the American Philosophical Society, the LaGorce Medal from the National Geographic Society, the Thurlow Award from the Institute of Navigation, the Gold Medal of the British Institute of Navigation, plus numerous other citations and awards.

Captain Weems has been known by a variety of names. Some think of him as "the Grand Old Man of Navigation," the title I have chosen for this article. To his friends from the Naval Academy class of 1912 he is "Mammy" Weems, to some who want to indicate personal association he is "Daddy" Weems, and to many lifetime acquaintances he is just "Van."

Although his colorful personality easily dominates any meeting, a major part of Captain Weems' success has been recognizing and organizing the creativity of others. Many navigation instruments have come to see the light of day because he truly believed his motto, "Give it a chance." The famous Dalton computers and

Aboard ship in the late 1920s, Captain Weems teaching navigation to a petty officer.

plotting boards, including the famous E-6B computer, were conceived by a young Naval officer who might not have finished the project without Captain Weems' encouragement. His sincere interest in people has made Captain Weems known the world over.

Although navigation always seemed to come to the forefront, Captain Weems excelled in all undertakings. For example, he served as both Chief Engineer and later Commanding Officer of Naval vessels. During his seagoing days, he sat for the examinations and received both a Masters and Chief Engineers license, oceans unlimited, in the Merchant Marine. In addition to navigation berths aboard ship, he served as the first Air Navigation Research Officer at the Hydrographic Office. In the early '30s, he retired and conducted his own navigation business and school. Recalled to active duty in WW II, he served as Convoy Commodore at sea and also earned his Air Navigator's Wings. Quite remarkably at the age of 72 in 1961, he again was recalled to active duty to set up a class and develop a handbook on space navigation. At this early stage of space flight he was convinced that man, with his ability to see, think and reason, definitely belonged in the loop in space navigation. He therefore determined how the space navigator could use simple tools to check on the vast amount of available computerized data.

Unlike Columbus, Prince Henry the Navigator, Captain Cook, etc.—famous marine navigators of a different era—Captain Weems was in his prime when the airplane developed as both a mode of transportation and as a military weapon. The Wright Brothers were only nine years out of Kitty Hawk when he graduated from the Naval Academy. By his own account, one great influence on the direction of Captain Weems' life was his navigator duty on a ship stationed across the Atlantic Ocean to monitor the successful 1919 first transatlantic crossing by Navy NC-4 aircraft. Already an expert navigator, he began developing shortcut methods and adapting marine instruments to serve the new air navigation requirements.

Most modern air navigators would recognize his name as the originator of the "Weems Plotter." This simple chart plotter has survived almost 40 years without any change in concept. Although drift meters, calculators, and instruments appear among his inventions, his major contributions to air navigation were concerned with celestial navigation. This was the only long range system available until post WW II electronic systems and, later, the inertial systems again revolutionized the art of navigation. Basically, celestial navigation always has required four equipment items, although today they may be incorporated into a single computerized system in the more sophisticated installations.

First is the observing instrument, traditionally the marine sextant, invented in about 1732. But aviation use required a horizon system independent of the natural sea horizon. Many ideas were tried but the answer turned out to be the bubble sextant. Captain Weems worked with many major manufacturers in developing and testing sextants both here and in England. These instruments included the first Bureau of Standards octants, the single shot Link sextant,

Testing an early bubble sextant — note the navigation watch on left sleeve.

The predecessor of the modern hack watch — the Weems second setting watch with rotating inner, second dial.

and then the Arthur J. Hughes averaging bubble sextant. At the time the latter was developed, Weems was in England with Hughes, writing a British edition of Air Navigation and experimenting with sextants. Although air navigation had evolved from marine navigation, by WW II days the process had reversed. My first association with Captain Weems came when I was attached to his Convoy Commodore crew. During ocean crossings, we tested aircraft bubble sextants at sea, trying to extend their use into the night hours. To do this, we used the bubble horizon at night when the natural horizon was obscured.

The timekeeper is the second item needed for precise celestial navigation. Again, the basis was there in the highly developed Marine chronometer but we now needed an instrument which could be set to the exact second. Despite official pessimism, Captain Weems started working on a second setting watch. Finally, the grand sum of $80. was authorized to include this feature on a standard Navy watch. This predecessor of all modern hack watches used a small rotating second dial on the face of the watch. Later, the commercially available models had a rotating bezel around the outer rim with a sweep second hand. Without interrupting the movement of the watch, one simply set this bezel so that the second hand was on 60 minutes when the radio time tick of chronometer check gave the start of a minute. Obtaining exact time to a fraction of a second is not a great feat today, but in 1930, it was a frustrating endeavor. The Weems second-setting watch paved the way for a number of excellent navigation timepieces of the hack watch variety.

The almanac is the third item required for celestial navigation. Few active duty navigators today would remember anything other than the tabulation of Greenwich hour angle of the body, or of Aries, against Greenwich time in the almanac. Not so before the days of Captain Weems. Celestial navigation in the 1920s required using an almanac for ephemeral data listing positions in terms of declination and right ascension, requiring a computation to achieve Greenwich hour angle. The Weems almanac was first published by the Naval Observatory in 1933 but then dropped after one year. It was then published by the British during the '30s and therefore available here in the states. In 1941, a change was made at the Naval Observatory, and since that time we have had a direct tabulation of Greenwich hour angle and declination to define the positions of the celestial bodies.

The fourth celestial navigation requirement is the computation involved in the spherical triangle. In pre-aviation days the marine navigator used logarithms in a long and tedious procedure to solve the problem with the same basic formulae currently used on small handheld calculators. While teaching navigation at the Naval Academy from 1924-27, Captain Weems received some Japanese celestial tables by Ogura, which were the basis for his Line of Position book. This was the first of the so-called "short-methods," followed by Ageton, Dreisonstok, and many others. These were followed by the inspection tables, HO 214, 249, 229, etc. *Editor's Note: For a more technical discussion, see any recent edition of* American Practical Navigator *published by the US Naval Oceanographic Office as HO Publication No. 9.*

The most significant invention, however, was the Weems Star Altitude Curves developed in the late '20s and early '30s. This book of precomputed altitude circles of three stars was the basis for celestial navigation in the early WW II days by the Army Air Corps. A set of tables, similar to HO 249, had to be hand-computed to obtain data for plotting the curves. This was a gigantic undertaking before the days of the electronic calculator. Today, Captain Weems is most proud of these Star Curves. He spent about 10 years and

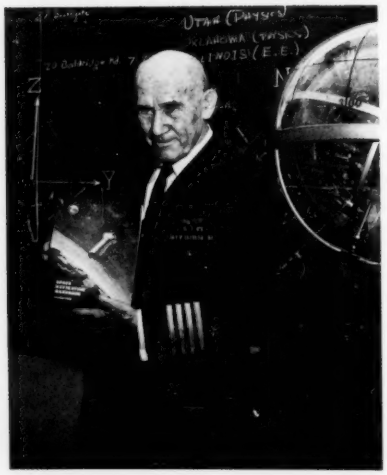
The first method of celestial navigation using precomputed star altitudes — these Weems tables were widely used by the Army Air Corps in WW II.

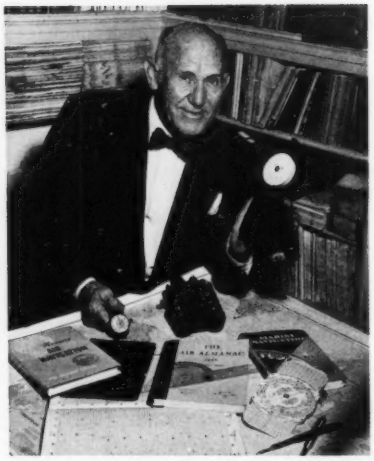
all the funds he could accumulate to complete this project privately after his first retirement from the Navy. At the start of the war, a method for long range celestial navigation was in demand and the Weems Star Altitude Curves were officially adopted by the Army Air Force. His books were both patented and copyrighted, a very unusual situation, as they were both a printed page and, in a sense, a machine. These inputs into all phases of celestial navigation enabled our military forces to more successfully carry out many missions. To Captain Weems, any idea involving the science of navigation merits an article. In addition to his standard textbooks on air and marine navigation, he has produced hundreds of widely-published articles.

At age 60, Captain Weems continued to work out at the Naval Academy gym, only a few blocks from his home in Annapolis. He wrestled midshipmen who generally received the surprise of their life when they took on the "old man." In his 70s, he was still playing water polo in the Academy pool with any group of young officers foolish enough to enter the water with him.

Captain Weems' accomplishments cover many areas. Perhaps one of his most lasting contributions was organizing the Institute of Navigation in 1945. As a co-founder, he was one of the guiding lights during the organization's formative years. In 1948, he flew over the North Pole with the USAF. With his son as pilot, in 1950, Captain Weems navigated a light plane from London to Alice Springs, Australia without radio, using his many dead reckoning instruments and a bubble sextant for celestial over water. In 1959, he joined Ed Link, of Link Trainer fame, in an underwater archeological exploration of the sunken city of Port Royal. He

Captain Weems with the space navigation handbook he developed after being recalled to active duty in 1961.





Captain Weems with some of the books he authored and instruments he developed.

took up skin diving to work alongside a group of young divers. For an old water polo player, it was a natural. When Link built his famous research vessel, Sea Diver, Captain Weems was invited to navigate on a transatlantic crossing to Israel for explorations there.

Captain Weems' life of technical excellence and inspiration is especially remarkable considering the great personal tragedy of losing both his sons, who gave their lives in the military service of their country. After an association of 35 years, I would have difficulty choosing Captain Weem's most important contribution to his fellow man. Perhaps it would be one which has never appeared in print before. During his WW II duty as Convoy Commodore in charge of large convoys to Africa and later to England, not one of the thousands of merchant vessels under his command was lost to enemy action. For that I especially pay tribute to my old mentor and friend. His classmates in 1912 already had him sized up correctly when the yearbook "The Lucky Bag" carried this comment beside his picture "And, strange to tell, he practiced what he preached."

Mr Dunlap first joined Captain Weems at sea during WW II and subsequently was associated with Captain Weems' commercial firms for about 30 years. Mr Dunlap authored 5 books and 25 articles on air and marine navigation, and coauthored the twelfth edition of Dutton, the standard marine navigation textbook. He is president of Dunlap Enterprises, Inc., Annapolis, Maryland.

and the navigator

Major Roy G. EMERSON
4235 ISD Sq
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Captain Vaughn L. BUTTERBRODT
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Plattsburgh AFB, NY

What is Instructional System Development (ISD)? How is it accomplished? What will ISD do for me and aircrew training programs? These questions and many more must be answered before meaningful ISD work can be performed in any navigator flight training program, whether it be SAC, MAC, TAC or ATC.

To understand how ISD is performed, we must first view the training system as a whole. Then from this perspective, we ask, "What are the methods of ISD?" The answer is in AFM 50-2 and AFP 50-58, Vols I-V. Because their specialized language is somewhat unfamiliar, these manuals are not always the best means to describe ISD methods. As stated by Major General Oliver W. Lewis in the *Air University Review:*

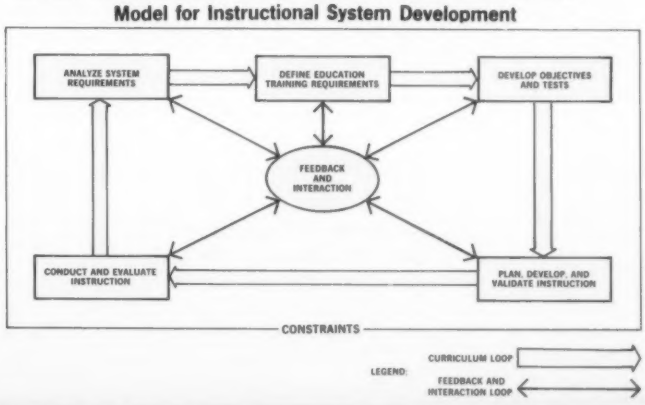
> "Applying the systems approach in instructional system development is the orderly process of (a) gathering and analyzing job performance requirements; (b) translating job performance requirements into behaviorally stated learning objectives; (c) identifying, developing, and integrating operating resources and instructional techniques and procedures, based on effective technological advancements in education and training, to provide the required instruction; and (d) assuring achievement of behavioral objectives and confirming that these objectives fully support the job performance requirements.
>
> "The process identifies the best possible combination of desirable features and alternatives. On the basis of objective and limiting factors, the most cost effective alternative is then selected. The output of the process is an integrated combination of resources (students, instructors, materials, equipment, and facilities), techniques, and procedures, efficiently performing the functions required to achieve specified learning objectives."

Every command has different techniques in completing the five-step ISD process, but the outcome should be the same. Let's look at the SAC ISD effort being conducted for the KC-135 navigator and see how this method applies to a 20-year-old weapon system. Like other commands, SAC encountered many growing pains in establishing the ISD machinery for the KC-135 navigator combat crew training course. Many of these problems still exist. Organizational structures and lines of communication had to be resolved, as well as educating CCTS personnel on the ISD process and identifying ISD personnel. The most important task, however, was training ISD personnel in the skills required to perform ISD work. Two KC-135 instructor navigators were designated as Curriculum Development Managers (CDM) and assigned to the ISD Division. They received formal training in Dr. Robert F. Mager's "Criterion Referenced Instruction" course which is compatible with the five-step ISD model in AFM 50-2. Obviously, the ISD process cannot be discussed in detail here but its highlights will be explained.

WHAT DO WE TEACH?

ISD work is now ready to begin. First, the KC-135 navigator course developers must gather and analyze job performance requirements. According to AFP 50-58, Job Performance Requirements (JPR) describe what a person must do to perform his operational jobs. They are composed of lists of tasks in sequence of performance, task descriptions (which describe what, why, when, where and by whom tasks are

Model for Instructional System Development



performed), and standards. The process of deriving task information is referred to as the "task analysis."

Subject Matter Experts (SME) are used in defining the tasks required to perform the job of the KC-135 navigator. An SME is defined as any KC-135 instructor navigator in the CCTS. To compile this task listing, several sources are used. Since a training program exists, a goal analysis is performed on its existing objectives. The CDM, working with the designated SME for a particular subject, accomplishes the goal analysis. The goal analysis converts current, vague course objectives into observable and more specific objectives. An example of an old objective might be:

"Be familiar with the parts of the APN-59 Search Radar."

The goal analysis would convert the old objective to:

1. Locate the APN-59 Search Radar control panel.
2. State the function of knobs and switches on the APN-59 control panel.
3. Locate the three APN-59 Search Radar circuit breakers.

Obviously, locating and stating are more observable and measurable than being familiar with something. A second data source is to flow chart ground and flight activities for all crew members. This includes both checklist and nonchecklist items for normal, abnormal, and emergency procedures. The example in AFP 50-58, Vol II, is similar to that used by the KC-135 curriculum development managers.

When the flow chart is completed, task descriptions are performed on all the tasks in the flow. These task descriptions are recorded in the form of discriminations and rules. When each discrimination and rule is accomplished by the navigator, successful job performance is the result.

With the goal analysis and flow chart complete, a correlation of the two data sources must be performed. This correlation will result in a complete task listing from mission preparation to in-flight activities to post flight with all skills, knowledges, and attitudes identified. While the task description is being written, a need-to-know filter must be applied to select only those skills and knowledges necessary to perform the job. If the skill or knowledge meets at least one of the following criteria, it should be retained for training:

1. Must be done on the job.
2. Job performance depends on knowing it.
3. Job decision or problem solving depends on it.
4. If omitted, poor performance or a safety risk results.

One of the major ISD successes in every program is identifying and eliminating superfluous training items. Actual job requirements dictate course development.

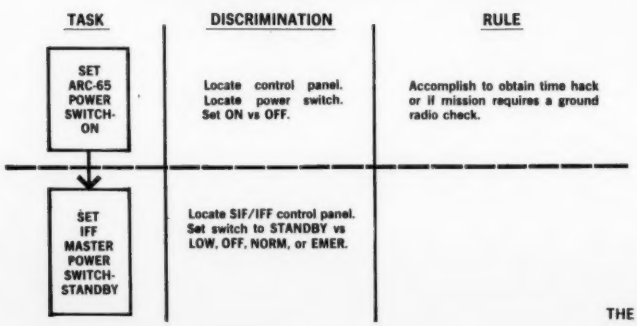
When defining education and training requirements, the CDM must also identify any skills and knowledges already attained by the new students (target population) prior to receiving the course of instruction. For example, training a new student tanker navigator on grid theory would not be cost effective since this already has been accomplished in Undergraduate Navigator Training.

TELL THEM WHAT TO DO

With the task analysis and listing completed, objectives and tests must be written. Well written criterion objectives and tests provide the heartbeat of ISD instruction. An objective is a precise statement that describes: (a) The behavior to be performed, (b) How well the behavior should be performed, and (c) The conditions under which the behavior is to be accomplished.

An example of the typical tanker navigator objective is: Given an N-1 Compass Master Heading Indicator, T.O. 1C-135(K)A-1, and Navigational Data, configure the N-1 compass for grid/magnetic operations in accordance with the Grid Entry and Grid Exit checklists. Setting of headings and latitude must be accomplished without error.

In a training situation, objectives serve three distinct functions. Teaching, learning, and evaluating stem directly from the objectives. But objectives do not stand alone. They must be accompanied by well written criterion tests. These


TASK
DISCRIMINATION
RULE
SET ARC-65 POWER SWITCH-ON
Locate control panel. Locate power switch. Set ON vs OFF.
Accomplish to obtain time hack or if mission requires a ground radio check.
SET IFF MASTER POWER SWITCH-STANDBY
Locate SIF/IFF control panel. Set switch to STANDBY vs LOW, OFF, NORM, or EMER.

tests measure the performance specified in the objective. In the KC-135 navigator training course, each lesson has an objective and criterion test. Hands-on testing is always pursued by the course designers; Cockpit Familiarization Trainers (mockups) and Part Task Trainers (radar equipment rack and T-10 trainers) are used extensively for measuring student performance.

TELL THEM HOW TO DO IT

With the objectives and tests written, actual course design begins. First, the instructional media must be determined for each objective. Or, put simply, what is the best way to instruct toward the stated objective? In the KC-135 navigator training course, a multitude of training media is available. This could include technical orders, course books, sound-slide presentations, video tapes, trainers, and the aircraft. The course developer's goal is to teach the student the specified skills using the most cost effective method.

Course books are then outlined and reviewed for content. Lessons are arranged in prerequisite skill sequence so that the learning path is well defined. This allows the student to progress from lesser to more difficult skills. For example, a lesson on setting the APN-59 Search Radar for preflight would not come before a lesson locating and stating the function of APN-59 knobs and switches on the control panel. The student does not progress to the next lesson until the current lesson criterion test is successfully completed. This guarantees attainment of all skills required for each succeeding lesson.

Students use several different learning environments. Each of these environments lends itself to a specific learning activity. The ISD course designer matches environments to learning activities. These include:

1. Classroom - Lectures and self-study work area.
2. System laboratory - Equipment part task trainers used for hands-on training.
3. Learning Center - Cockpit Familiarization Trainers for hands-on training and learning carrels for viewing sound-slide and video tape programs.
4. T-10 trainer - One navigator station environment with limited capabilities for student skill development in navigation and rendezvous procedures.

DOES THE INSTRUCTION WORK?

With the course developed, we must see if the instruction is doing what we want it to do. Several classes are used to validate the course material. Validation data is collected through student/instructor questionnaires and interviews. When all the data has been gathered, the CDM and SME for the particular subject make the necessary revisions to the course materials. With this complete, the course is ready for full implementation. Constant feedback from instructors and students is used to update each course. ISD strives to give the student the very best instruction possible. If change is required, then change will be made.

Now that the course book has been finalized, production of the course materials begins. This includes story boarding video tape and sound-slide scripts and writing course book texts and other software for the course.

Currently all courses on KC-135 aircraft systems have been completed. The system courses provide for individualized instruction and a certain degree of self-pacing by the student. Students work on their own with no formalized lectures. The student uses the technical data and associated manuals and regulations as instructional media just as a lawyer uses a law library. When students complete the lesson activities, they practice the skills defined in the criterion objective and test. A sample test is provided in each lesson to tell the student exactly how the objective is to be tested. When students feel competent in the required skills they ask for the test. In most cases, the instructor administers a hands-on test criterion in a trainer. This allows the student to encounter the equipment as much as possible in the learning process.

YOUR ASSISTANCE IS NEEDED

There is nothing mystic about ISD. It is a systematic means of arriving at a decision or, in our case, arriving at the best means of instructing

students. Instruction, whether it be by lecture, course book, or video tape, must be cost effective and achieve the desired objectives. If it doesn't meet these criteria, ISD has not done its job. You and each training agency must understand ISD since lack of understanding leads to lack of support. Support from all echelons insures ISD success.

A graduate of Miami University, Major Emerson completed UNT and the KC-135 CCTS in 1967, followed by assignment to Wright-Patterson AFB. At Castle AFB, he instructed CCTS and subsequently served in the Standardization and ISD Divisions. Since March 1978, he has been assigned to the 4235 ISD Sq, Carswell AFB, as ISD Team Chief for Advanced Tanker Cargo Aircraft.

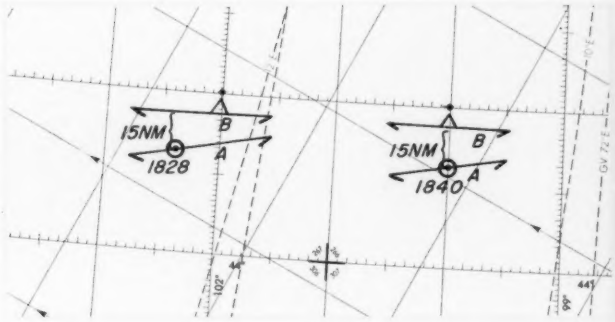
Captain Butterbrodt graduated from Coe College and entered the Air Force in 1967. After UNT and the KC-135 CCTS in 1968, he was assigned to Kincheloe AFB. He next served as a CCTS instructor and in the ISD Division, Castle AFB. Assigned to Plattsburgh AFB in 1977, he is Chief of Curriculum Development, FB-111 Combat Crew Training Course.

TO THE EDITOR

(continued from page 3)

Figure 1

Correct LOP A falls through both DRs. Erroneous LOP B is 15 nm from DR, with or without motion of observer applied.



1840 shows an HC of 62-00 and a Zn of 180 at 100°W (the solution can be found on p. 35 of HO 249, Vol III — LHA=0, DEC=17). We are taking one shot on the body, 12 minutes early, at 1828. Let's suppose we have an HO of 62-00.

We'll do it the accurate way first, then the traditional way, and see what the error is. Navigator A chooses an assumed position as close to the shot time DR (A) as possible, at 102° W. He precomps for shot time, 1828, and gets:

HC	61-41 (five LHAs down)
Zn	170
Motion of body	None (shot time same as solution time)
Motion of observer	+6
TOT ADJ	+18
Intercept	37T

The LOP plots as shown in Figure 1. If we leave out motion of the observer, we'll get an LOP for

shot time with an intercept of 19T as shown in the illustration. Move the LOP to 1840 with GS and track, and it will end up in the same place as it did with motion of the observer. This is a good LOP with which to compare method B.

Navigator B precomps for 1840 (fix time) and uses motions to shoot 12 early. To eliminate motion of the body error for bodies in transit, he goes back 3 LHAs and takes the total change in HC for 12 minutes as his motion of the body.

HC	62-00
Zn	180
Motion of body	+7 total
Motion of observer	0
TOT ADJ	+7
Intercept	7T

This LOP plots out exactly 15 nm, not 22, from the correct one (Figure 1). Again, motion of the observer is not the problem because, being zero, it has correctly moved the perfect course line LOP from 1828 to 1840. Extend the LOP out to the 1828 DR, to see where it is at shot time, and there is still 15 nm error (Figure 1).

Part of the problem with LOP B is that we have an adjusted solution for 1828 (by means of motion of the body), but we still have a Zn for 1840. If we look 3 LHAs down we see that the 1828 Zn, from the 100°W assumed position, should really be 174. If we plot the intercept with a 174 Zn, and extend it out to the 1828 DR, we find that we have taken care of 11½ miles worth of the error (Figure 2).

The rest of the error is caused by the way we draw the LOP—as a straight line. The celestial LOP is actually a circular LOP—a circle of equal altitude—and if the assumed and actual positions differ laterally by enough distance, the true circular LOP will diverge from the straight line we draw on the chart. If we could place one point of the dividers in the subpoint and the other 1680 nm away near the 100° W assumed position and strike an arc towards 102° W, we would find that the properly drawn LOP would coincide with the good LOP A. That checks, because the LOP changes 4 degrees in direction between the two assumed positions, and half of this amount, or 2°, taken for the 105 nm between DRs, would amount to about 3½ miles (Figure 2).

The geometric "system" recommended for finding the ideal assumed position says that it should lie along a Zn line drawn through the shot time DR, which is true, and that it must also have a zero intercept, which is not true. Small does not necessarily mean accurate, as even stated in the opening paragraph of the article. All that needs to be said about the selection of an assumed position is that with the intercept method, the lateral (perpendicular to Zn) distance between assumed and actual positions should be as small as possible (i.e., lie near or along the Zn line). As long as this condition is satisfied, the assumed position can actually be any distance from the actual position, and the intercept will be perfectly accurate. This condition is usually satisfied by choosing an assumed position as close as possible to the fix time DR, but is complicated by people who insist on shooting 12 minutes early.

The recommendations for shooting order of speedlines first, courselines last, may or may not be valid. If you know your speed better than your

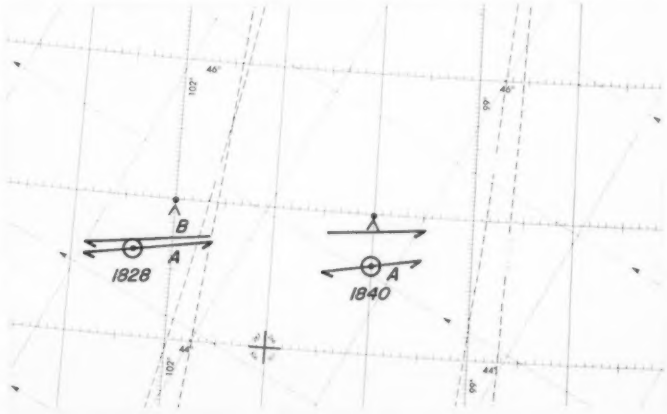


Figure 2

When plotted with correct Zn of 174 for its assumed position, LOP B is much better. Circle of equal altitude, if it could be drawn, would look like the dotted line.

course, fine. But if you are unsure of your speed, and know your course accurately, you should shoot the speedline closest to fix time. But since you rarely have this sort of privileged information, and all other reasons are invalid, I have always taught that it's not worth hassling anyone to change the shooting order of the stars. The stars are listed in the book in the order of increasing Zn for good reason—it's easier to precomp them, and easier to shoot them that way.

To summarize, the error in the article's example problem would be 15 miles, not 22, all other factors being controlled; motion of the observer is not, and cannot be in error; the reason for the inaccuracy is plotting an early shot with a fix time Zn and the fact that we draw cel LOPs as straight lines; and, finally, I wish that everyone would leave people alone on changing the shooting order of the stars. You want the most accurate way of shooting celestial? Three LHA, with bracketed 4-0-4 shooting schedule and assumed position as close as possible to fix time DR is not only the most accurate method possible, but also the fastest and easiest. Perhaps an article on the fallacy of shooting early in order to "be ahead of the aircraft" would be more useful to everyone than all of these complicated methods to combat the inaccuracy of shooting early.

Gary C. Eickmeier, Capt, USAF
71 AREFS
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GROUND PLOTTING BY SIXES

Captain William H. PRICE
[illegible] Bomb Sq
Fairchild AFB, WA

There probably have been as many different celestial navigation techniques as there are navigators. The majority of navigators today use the air plot exclusively. Recently on a nav leg requiring quite a bit of alters at the start, I was not certain of our actual position in relation to the desired course. Since I was carrying air plot, I had to spin a DR from the recorded winds and then plot every time I needed to check our position. In a very short time this became ridiculous as I was getting behind the aircraft. About then, I tried a method I had heard about but never used. The usual air plot method is to keep a log averaging the winds and then suddenly discover where you are at the end of a 30 minute DR (average pacing). But why not just read the Doppler and plot the aircraft position every few minutes. I did and thus was introduced to ground plotting for celestial navigation.

With a little practice, ground plotting on a nav leg is accurate and the navigator knows his exact position at all times. Also, it is especially useful for adhering to centerline. It works something like this:

1. Take the base fix in the usual manner and note your instrument readings after four or five minutes have elapsed (Time, TAS, GS, GH, Drift). Log these readings in the information block.
2. By using multiples of six minutes of time, the DR is simplified since the aircraft travels one-tenth the groundspeed in six minutes. Just apply this to the groundspeed. For example: six minutes at 450 knots is 45 nm. No need for a DR computer—just take the dividers and plot 45 nm.
3. Note the aircraft heading and drift by reading the drift from the Doppler dial. Mentally apply this drift to the right or left of aircraft heading and plot the course and distance.

This system will give you a DR position in about 30 seconds. If you wait 12 minutes to DR, just double the distance traveled. This works out well for 30 minute pacing and carrying DRs of 6-12-12. If your last DR to MPP is not a multiple of six, you can always pick up the computer and spin out the distance. A Doppler is not necessary since

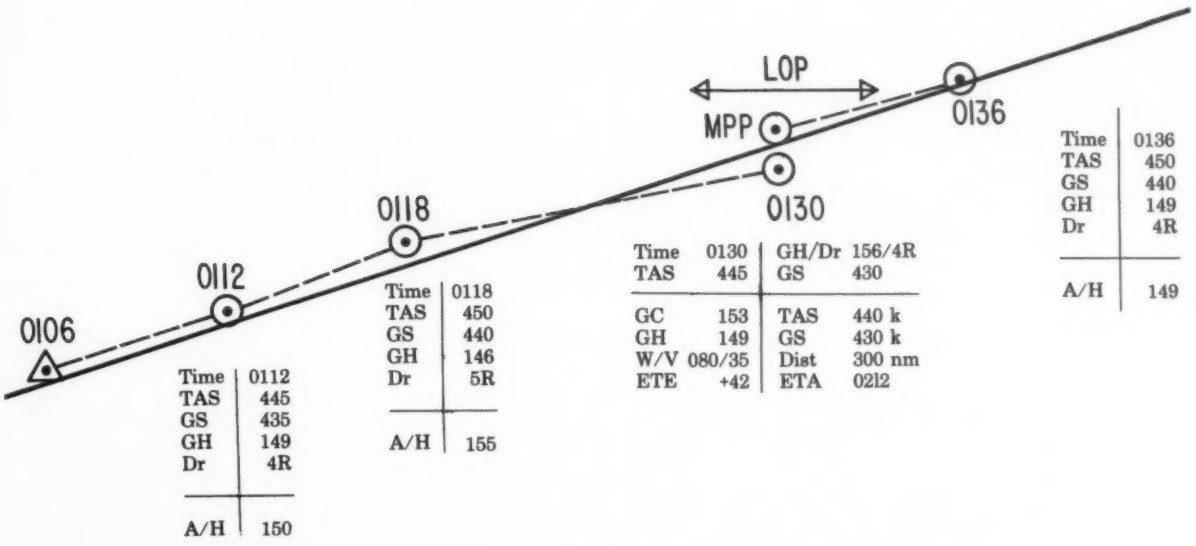


Figure 1

a drift may be derived from any source. Should you need to transition to night celestial without using a Doppler, begin air plot out of the last DR when necessary. When precomping in the air, you can always throw out a long 30 minute DR in addition to the shorter ones.

The example in Figure 1 shows several alters back to track prior to the MPP. A pacing schedule of 6, 6, and 12 minutes is used. Station circles may be a little different from the usual format. Use an abbreviated station circle for the intermediate positions and an expanded one for fix time. You will still need an outblock showing predicted heading and time to destination.

Time	0106
TAS	440
GS	455
GH	056
Drift	4 L
A/H	053

IN	Time	GH/Dr
	TAS	GS
OUT	GC	TAS
	GH	GS
	W/V	Dist
	ETE	ETA

Figure 2

Advantages to ground plotting are:

1. Reading the instruments at regular intervals rather than guessing because you forgot to check them.
2. Forseeing course deviations early and correcting back to desired track. The result is flying center line all the way.
3. Eliminating most of the need to pick up your DR computer.
4. Prevents overshooting ETAs because of a change in groundspeed. You are keeping up with the aircraft.
5. There will be no surprise when you finally put out a position after a long period of time.

Disadvantages are:

1. If winds are constant, this system may be more time consuming.
2. The replotter may not be familiar with the method (so leave him a note).

You should be cautious of whether this method is consistent with mission requirements. If you cannot use the Doppler on a night cel, the method becomes less practical. An in-flight wind may be derived any time by using GS, GH, and drift on a computer. You should practice before trying a ground plot nav leg.

Captain Price graduated from Eastern New Mexico University in 1971 and received his OTS commission in 1973. Captain Price currently is a radar navigator with the 325th Bomb Squadron, Fairchild AFB.

Tweet

Captain Eugene A. ROSE
455 FTS
Mather AFB, CA

A six thousand pound dog whistle? Nope. An Air Force aircraft used to train student pilots? Yes. A fighter type aircraft used to train student navigators at Mather Air Force Base? You must be kidding!

The T-37 is alive and well in UNT. Since the conversion to the all-jet navigator training program in the summer of 1975, the T-37 has assumed increased importance in navigator training at Mather. This article will familiarize navigators throughout the Air Force with this new phase of training and briefly describe some of its fundamental elements of instruction.

The T-37 training is conducted by ATC instructor pilots assigned to the 455th Flying Training Squadron. The unit, consisting of nearly 50 instructors, is composed of recent UPT graduates and pilots with previous operational flying experience. At present, this experience covers nearly all Air Force aircraft, except some of the more recent tactical fighter aircraft. The squadron provides both academic instruction in Advanced Airmanship and flying training in the T-37.

Advanced Airmanship is the third phase taught in UNT. The academic instruction consists of basic VOR/DME navigational procedures (RMI only), course intercepts, VFR map reading, wind analysis, dead reckoning, use of low altitude charts, approach plates and AFM 51-37 instrument procedures, time control, flight plans, use of FLIP, clearing, crew coordination, and an introduction to the T-37 aircraft.

T-37 flying training consists of the first five flights in UNT. For many students this is the first flight in an Air Force aircraft, and occasionally the first flight of any kind. The flights are carefully scheduled so that they closely follow related classroom instruction and two practice sorties in the T-40 simulator. The first two flights are VOR/DME airways navigation missions and are generally flown around 15,000 feet MSL. The next two rides are essentially VFR map reading routes flown at around 10,000 feet AGL, although an IFR clearance is maintained throughout the flight. The fifth and last sortie is a combined formation and contact sortie that includes an introduction to acrobatics and maximum performance flying. All rides are graded but there is no check ride flown in the T-37 phase of training.

Now that you are familiar with the general course, let me discuss some of the fundamental elements of instruction:

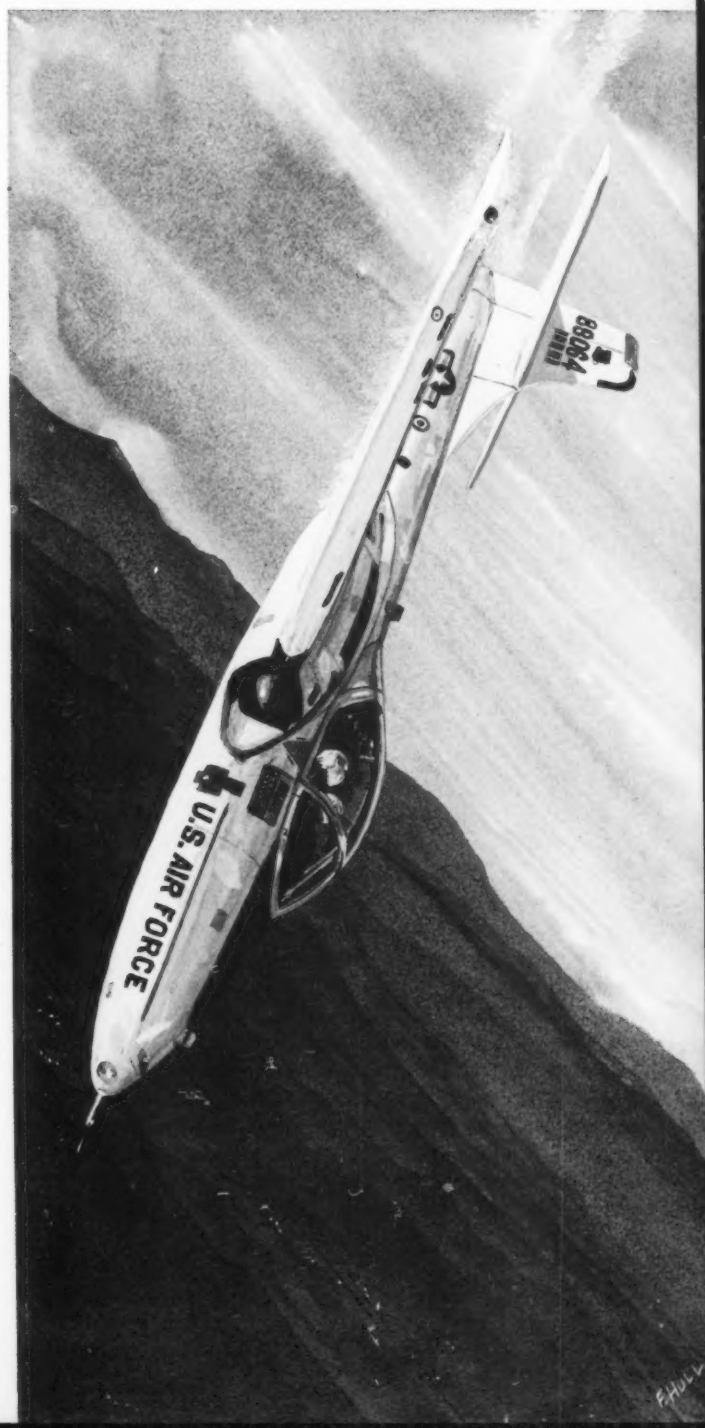
CLEARING — Clearing is one of the most important jobs that a student navigator has in the T-37. Not all navigators will have a crew position with a capability to see outside and clear, but many will. Even those who will not have a window can gain an appreciation for this time consuming, difficult, and critical job continually performed by all pilots. Also, it is essential to have everyone possible clear at all times when flying in the Sacramento area as 60% of the general aviation traffic in the United States is over the great central valley of California. The collision potential is very high and proper clearing is absolutely necessary. Clearing must be done continuously—with only momentary breaks to perform other duties. Much as a pilot always

refers back to the attitude indicator as the primary reference point when flying in the weather, all crew members with the ability to clear must look outside for other aircraft. The importance of proper clearing is continuously stressed by all IPs and we try to keep in mind that Air Force navigators are initially taught to clear by a member of the 455 FTS.

CREW COORDINATION AND CHECKLIST USAGE — The student navigator is an active and aggressive crew member who works with me to accomplish our training mission. We use the "challenge and response" method of checklist usage. The student is the checklist manager and must insure that all checklists are completed properly. If ever in doubt as to whether I responded properly, the student must ask me again for my response. I never criticize a student for asking a second time. Coordination between the pilot and navigator as to condition of flight, i.e., altitude, airspeed, heading, etc., is stressed with particular attention to altitude calls. The student navigator must advise the pilot approaching all level offs. I point out to my students that the height above touchdown (HAT) for the PAR to runway 22L at Mather is 100 feet. Since the altimeter can have a 75′ error, two or three seconds of inattention resulting in a missed altitude call can spell disaster in the weather. From the very first ride, I teach my students to maintain a questioning attitude about everything that takes place in flight. Every aviator makes mistakes and the student should not hesitate to challenge the instructor. There is no such thing as a dumb question when flying—the student should participate as an active member of the crew.

RADIO PROCEDURES — The student is in charge of the navigation and communication radios throughout the flight and must TIM (tune—identify—monitor) the correct VOR and DME frequencies as well as manage the transponder from takeoff to landing. The UHF communications radio is also the student's responsibility, except during the instrument approach phase when I usually make the calls to let the student concentrate on the instrument approach. Brevity and clarity are stressed in this area. With only five T-37 rides, the student must pass his initial "mike fright" and practice in the "real world." Standard Air Force terms are taught but when in doubt, state in plain English what you want to get across. Although a recent call one of my students made, namely "Oakland Center, Colt two zero, level one-three-thousand nine-hundred and seventy-five feet" was a little bit of overkill, I had to give him credit for accuracy.

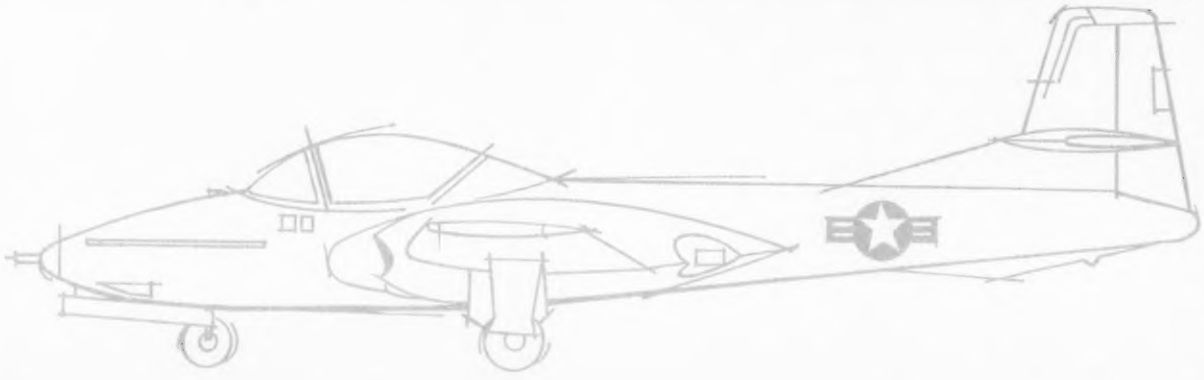
WIND ANALYSIS — All flight planning in the T-37 is accomplished "no wind" as the student has not yet been introduced to the hand-held, air navigation computer. Once airborne, we discover that wind significantly affects our aircraft and we



attempt to analyze its direction and velocity. Towards the end of the first flight, the student begins to anticipate the effects of the wind when turning to a new course. One technique I teach is that 10 degrees of drift correction is necessary to compensate for a crosswind component equal to 1/6 of your TAS. Since we normally fly our sorties at 240 KTAS, 5 degrees of drift correction results in a 20 knot crosswind component. Using a standard DME groundspeed check, the student can also determine the headwind or tailwind component and then mentally combine these two vector components of the wind. This can be done on the face of the RMI, much as one solves a fix-to-fix. When turning to a new course, the student then applies this same process in reverse and provides a new heading that includes a drift correction angle. Adjustments are made in ETAs based on the new headwind or tailwind components. Using this basic technique, it is not difficult to determine the actual wind at altitude within 10 degrees and 5 knots.

TIME CONTROL — On the first two rides the student never changes airspeed and we always fly at 240 KTAS. Time control then becomes nothing more than determining the actual groundspeed through DME checks and then revising ETAs. The problem is much more complex on the third and fourth rides (map reading) as the student must make airspeed adjustments in order to reach each checkpoint on time. We teach two methods, the incremental and the 10%. Essentially, in the incremental changing the airspeed by 1/6 will provide a 10 second per minute gain or loss. For the second method, a 10% airspeed change will result in a gain or loss of 6 seconds per minute. Both of these methods are based upon correcting in a no wind situation. If the wind caused the off time, which is usually the case, then the rate of correction may differ, but at least these corrections get the aircraft moving in the right direction—the important factor. There is nothing more discouraging to me as an IP than having a student realize he is 30 seconds behind time, spend 2 minutes figuring appropriate airspeed correction, and end up 60 seconds behind. The secret to good time control is to anticipate the winds and change airspeed as soon as a deviation is noticed. The incremental or 10% method can then be used and the airspeed further refined as necessary.

VFR MAP READING — The key here is to go from the *map to the ground*—not the other way around. At this time I introduce the student to a new term, "assumed position." While looking at the elapsed time from the start of the map reading route, and referring to the tick marks on the chart, the student determines the present location, i.e., assumed position. The student then projects the flight path on the map, picks out some good visual references such as lakes, rivers, airfields, bridges, mountains, towns, etc. The student *then* looks for the selected landmarks on the ground. As soon as the landmarks are located, the student should try to confirm them with at least one more visual reference, and then use the landmarks to analyze track and time. I encourage the student to find the next turn point as early as possible. If it is moving neither right nor left in the windscreen, then the student has the drift killed and is tracking to the point. As a bottom line, if lost, go back to the "big picture," start with something large and obvious, maybe a city or lake, and from there determine general orientation. The student can then proceed from the obvious to the less obvious and find the exact location. Easy to say—but hard to do. The ability to read a terrain chart (we use TPCs) cannot be mastered in two rides, but we do at least provide an introduction to the task. VFR map reading is also an excellent lead in for radar



interpretation that will come shortly after completion of the T-37 phase.

PRIORITIES — This item isn't even on the grade sheet but to me it ties together everything that we try to teach in the T-37 phase. The student must learn that everything cannot be done at once. The most important things come first, i.e., clear and navigate. When time permits the less critical things can be done, such as checklists and flight log entries. I encourage the student to get things done early if possible. Fuel can be logged a minute or two before the turn point by subtracting the fuel flow per minute from the total at the time. Control ETAs can be computed as early as possible instead of computing them one at a time over a turn point when things are all happening at once. The key to the art of airmanship is: *Keep your wits about you, don't get flustered, line up your tasks, and get them done one or two at a time.* Everyone has heard the old adage that flying is "hours of boredom punctuated by moments of stark terror." Perhaps it overstates the truth, but the general principle is as true today as ever. To help ourselves function during those moments of "stark terror" (the busy times), it only makes sense to do jobs early when possible. As an aid to determining priorities, the student is taught to *aviate—navigate—communicate*, in that order. To do that effectively is the essence of airmanship, and that's what we are teaching in the T-37.

Even though the T-37 has been at Mather for only slightly over 3½ years, several major changes have occurred. Two of the most significant are the introduction of hands-on-training (HOT) and formation on the fifth sortie.

Hands-on-training consists of allowing the student to practice several basic flight maneuvers. Among these maneuvers are: straight and level flight, turns, climbs and descents, and airspeed changes through proper throttle technique. Also, the student is given the opportunity to practice AFM 51-37 unusual altitude recoveries as well as several basic aerobatic maneuvers. The goal of this training is to expose the student to the pilot's duties, thus making the student a well-rounded crew member. The goal is not to develop flying proficiency. Although the student is not graded on hands-on performance, this training provides the student with a greater appreciation of the flying profession.

The formation profile flown on the fifth ride has been in existence for a little over a year. The profile is a two-ship IFR departure to a contact working area over the Sierras near Lake Tahoe. Once established in the area, the two aircraft split up and accomplish selected single-ship maneuvers. Included among these are steep turns, aileron rolls, barrel rolls, loops, cloverleafs, lazy eights, the split S, and recoveries from inverted flight and unusual attitudes. The student may fly the recoveries, as well as some of the acrobatic maneuvers. After this single-ship portion, the formation then rejoins for some wing work and extended maneuvering where the second aircraft flies approximately 500 feet aft of lead. The formation then normally makes an IFR recovery to Mather for a wing landing. This sortie exposes the student to some tactical type flying, develops an appreciation for the concept of mutual support inherent in formation flying, and helps develop the aggressiveness required in a tactical situation. Flight Mission 5 is not merely a demonstration ride. Although the student is not graded on his or her performance of formation duties, the student is graded on all other aspects of the mission. There is no check ride in the T-37 phase, but this is the last ride and the student must put together all that has been learned in the previous four flights and perform accordingly. This exposure to fighter type maneuvering also helps the student determine if a tactical assignment is desired after graduation.

Yes — The Tweets are alive and well at Mather. We are performing an important and unique mission. All of us in the unit are very proud of our role in preparing navigators for today's Air Force. The T-37 phase is still a new and evolving element of UNT, and the members of the 455th Flying Training Squadron look forward with confidence to the challenges of the future.

After Air Force Academy graduation in 1968, Captain Rose obtained a master's degree in Aeronautics and Astronautics from Purdue University. His assignment history includes pilot training, a SEA tour in the OV-10A, a SAC tour in B-52Ds, and an ASTRA assignment at the Pentagon where he also flew the T-39. He is presently a T-37 instructor pilot and Flight Commander in the 455th Fly Tng Sq, Mather AFB.

Nav Typhoon Chaser

First Lieutenant Nathan H. KRYS
54 WRS
Andersen AFB, Guam

60-16/MACSUP 1, paragraph 5-22b, states: Avoid thunderstorms and cumulonimbus clouds using the following criteria for Climbout-En Route-Descent:

a. FL 230 and above: 20 nm
b. Below FL 230: 10 nm
c. Tactical Operations: Below FL 230: 5 nm. Outside air temp must be above 0°C at flight altitude.

Similar rules apply to most Air Force aircraft. But the 54th Weather Reconnaissance Squadron (WRS), Typhoon Chasers, do not follow these rules during weather reconnaissance storm missions since their primary mission is tropical cyclone reconnaissance.

Generally, it's difficult enough navigating a great circle route in good weather. But, consider navigating into a typhoon, turning to avoid areas of dangerous weather, fixing the center of the typhoon, and then attempting to safely circumnavigate dangerous weather on an exit track.

The Typhoon Chasers collect valuable data for forecasters to predict the movement and future intensity of the erratic tropical storms and typhoons. These forecasts have saved countless lives and untold millions of dollars worth of property.

A tasked typhoon fix, oddly enough, begins with a satellite photo. Once the Joint Typhoon Warning Center (JTWC) suspects a tropical depression, the 54 WRS is tasked for an investigative mission of the suspect area. JTWC is responsible for issuing vital weather warnings in the Pacific area. The JTWC area is over seven million square miles bounded by the Date Line, Equator, and the Asiatic continent. We fly the investigative profile at 1500′, seeking a westerly wind since a westerly often indicates an impending tropical storm.

The Aerial Reconnaissance Weather Officer (ARWO), aboard the WC-130, collects pertinent weather data. When the ARWO suspects a wind shift he coordinates a new heading with the nav. These heading changes can play havoc with the nav's pacing—a heading change of 30 degrees or more every ten minutes! This happens all the time.

As the tropical depression gains in strength it becomes a tropical storm and eventually a full blown typhoon. When this occurs, JTWC levies a sortie to obtain the typhoon's exact position. The Typhoon Chaser navigator prepares a flight plan for the storm's predicted center. The pilot and ARWO prepare the before takeoff briefings including the planned penetration track. The flight plan must then be readjusted to allow for any late-developing changes. The navigator thoroughly preflights his radar since he will use it penetrating the storm to detect dangerous areas of thunderstorm activity in the aircraft's path. The Typhoon Chaser nav *must* be an expert in interpreting weather returns.

Takeoff and enroute navigation are normal, until at about 250 nm from the storm, the crew prepares for penetration. The nav will try to maximize right drift (northern hemisphere) while keeping the groundspeed and true air speed the same. When that is accomplished, wind direction will be directly from the left wing. This flight path leads directly into the eye of the storm.

The nav must spin a new wind each 50 nm into the storm. Spinning winds, watching the radar, avoiding the bad bumps and fixing at the same time make for a busy crew. Timely pacing, excellent crew coordination and interphone discipline are mandatory. The crew must work as a team—penetrating a typhoon is serious business.

Once in the eye, the pilots, nav, ARWO, flight engineer, and dropsonde operator coordinate finding the exact center of the storm. The pilot takes up an orbit track. The nav fixes the center. The engineer insures the aircraft is maintaining sufficient power to hold orbit. The ARWO records necessary data and coordinates with the dropsonde operator on releasing weather packages. The weather package transmits pressure, temperature, and humidity data to the aircraft. All this information is then tabulated and immediately relayed to JTWC. This data aids in developing and issuing vital weather warnings.

Now it's time to exit—exiting a typhoon is just as dangerous as penetrating. The nav continues avoiding the strong returns from the scope until finally clear of hazardous weather.

Hopefully, this article will induce some interest in weather reconnaissance and related fields. In addition to tropical cyclone reconnaissance, the 54 WRS engages in search and rescue, air sampling, aerial refueling, NASA recovery, and SAC and TAC deployments.

Flying in good weather is nice; however, such is not the case for a Typhoon Chaser.

Editor's Note: We recently received a news release from the Keesler AFB Information Office about another hurricane hunter. Captain Marvin A. Olson, 53d Weather Reconnaissance Squadron, has recorded 109 typhoon or hurricane penetrations from 1970 to the present. Of interest is Captain Olson's account of why he likes weather reconnaissance. "I find the idea of flying into storms a very exciting mission. The aspect...I like best is the humanitarian effort of providing information to the right people, who will, in turn, provide the public an early warning of where a storm is going to hit. I can...help someone, and, at the same time, be able to fly."

But providing these warnings creates some exciting moments for the WC-130 aircrew. Captain Olson tells of being "inside the center of a storm that was less than three miles in diameter and we couldn't turn the aircraft before we hit the wall cloud on the other side." On another occasion, "The turbulence was so bad that brief cases and maps were constantly glued to the ceiling..."

THE NAVIGATOR salutes the men and women of the 41st Rescue and Weather Reconnaissance Wing, and the Weather Reconnaissance Squadrons. We can take special pride in the accomplishments of the weather reconnaissance navigator.

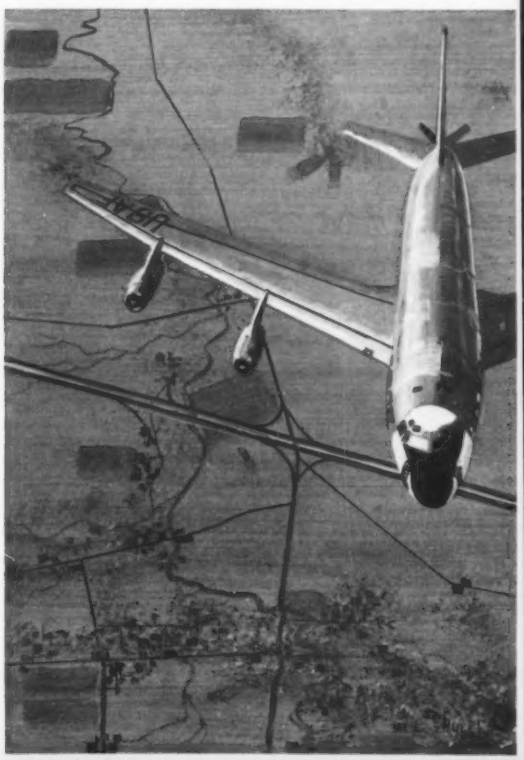
Lieutenant Krys attended the University of Wyoming on an AECP/AFIT scholarship and graduated in 1974. After completing UNT in 1975, he was assigned to the C-141 at McGuire AFB. At present, Lieutenant Krys is an Instructor Navigator on the WC130 with the 54 WRS, Andersen AFB, Guam.

PRESSURE PATTERN

Captain Charlton J. WATTERS, Jr.
AFIT School of Engineering
Wright-Patterson AFB, OH

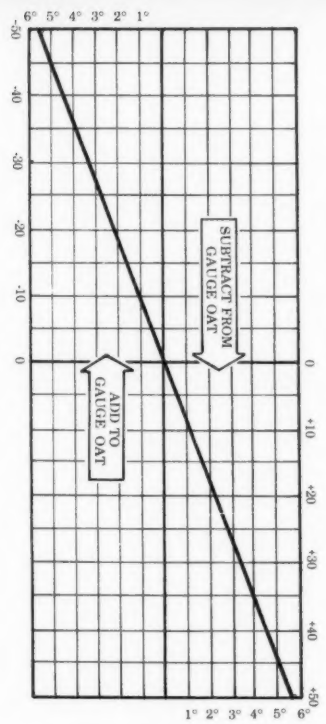
Temperature pressure pattern is known to many as a waste of time. Why? Because in spite of the work required to obtain a PLOP, the results are often less than stellar. There are, of course, several variables that affect any PLOP. The major ones are airspeed changes, altitude changes, and unusual weather systems.

Let's say that you were able to correct for most of these variables. Your PLOP would become far more reliable, wouldn't it? Well, you ***CAN*** correct for just about anything short of a broken temperature gauge or a wacky weather system. You should obtain a good PLOP in as little as 30 seconds using the checklist handout in Figure 1.



TEMPERATURE PRESSURE PATTERN

ΔT \ FL	"D" DIFFERENCE PER CHANGE IN OAT							
	270	280	290	310	330	350	370	390
5°	580	605	635	690	750	805	865	920
4°	464	484	508	552	600	644	692	736
3°	348	363	381	414	450	483	519	552
2°	232	242	254	276	300	322	346	368
1°	116	121	127	138	150	161	178	184
½°	058	060	063	069	075	080	089	092



CHANGE IN TAS FROM D_1 TO D_2 (KNOTS)

EXAMPLE: AT 1500Z, OAT= -23°C, TAS=460, FL 290
AT 1530Z, OAT= -27°C, TAS=440, FL 290

OAT_2= -27°+2°= -25°C

$\Delta T = OAT_2 - OAT_1$ = -2°C

FROM TABLE, "D" DIFF= -254

Figure 1

The table at the top of Figure 1 gives the changes in the "D" value for any given change in gauge OAT at the most commonly used flight levels. "D" differences for temperature changes beyond the limits of the table can be computed by adding the proper numbers. For example:

At 1300Z: TAS=450 Knots	At 1330Z: TAS=450 Knots
Alt=FL 310	Alt=FL 310
OAT= -28½°C	OAT= -35°C

In this case, the change in OAT would be -6½°C, or (-5°)+(-1°)+(-½°). The corresponding "D" difference can be found by adding the values for 5°, 1°, and ½°, respectively. Figure 2 shows the problem on Pressure Pattern worksheet.

Figure 2

TIME 1300	LAT 33N	D_1 FL 310		
TEMP °C -28½	TAS 450		=	
TIME 1330	LAT 33N	D_2 FL 310 $\Delta T = -35 + 28\frac{1}{2} = -6\frac{1}{2}°$ $= -5° - 1° - \frac{1}{2}°$ $\Delta D = -690' - 138' - 69' = 897'$	$\frac{-897'}{450} = \frac{ZN}{K(33°)}$	79R
TEMP °C -35	TAS 450			

TIME 1500	LAT 40N	D_1 FL 290		
TEMP °C -23	TAS 460			
TIME 1530	LAT 42N	D_2 FL 290 OAT_2 -27°+2°=-25° ΔT= -25°+23°=-2° ΔD= -254	$\frac{-254}{450} = \frac{ZN}{K(4/°N)}$	$18\frac{1}{2}R$
TEMP °C -27	TAS 440			

Figure 3

Now let's take a different problem and say that your TAS decreases from one "D" reading the next

At 1500Z: TAS=460 Knots	At 1530Z: TAS=440 Knots
Alt=FL 290	Alt=FL 290
OAT= -23°C	OAT= -27°C

Why bother with a changing airspeed? In our normal flight environment, every 10 knots of airspeed change that goes unnoticed will send an otherwise good PLOP 10 miles off into the weeds. As a general rule, increasing TAS will move your PLOP to the left and decreasing TAS will move it to the right.

Friction causes the error. Your temperature probe responds to increasing or decreasing TAS by warming up or cooling off. Before you can compare a temperature reading with a previous one, you must change your present reading to what it would have been at the previous airspeed. The difference between your present (corrected) reading and the previous one represents the actual change in outside air temperature.

Since the change in the example is -20 knots, enter the graph in Figure 1 with minus 20. Following the instructions in the arrow pointing to the "minus" side of the graph, ADD the correction factor to the temperature on the gauge. In the example, the correction factor would be 2°C (Figure 3).

This example appears in Figure 1 for in-flight reference. Once you have the corrected "D" difference, you can solve for the ZN displacement. Remember, a decreasing temperature yields a displacement to the right and vice versa.

In much the same way as airspeed, any change in altitude will induce an error unless you apply a correction. Practically speaking, a variance of ±50 feet will not matter. Pilots try to fly right on the desired altitude, and using altitude hold in conjunction with an AIMS altimeter (operating in RESET) makes the job simple.

One factor that must be accepted is an abnormal weather system. Pressure pattern navigation was designed when aircraft flew lower and slower than they do today. In the lower altitude structure, pressure systems behave much like their theoretical counterparts. But at high altitudes, navigation involves flight through one or more jet streams or crossing the tropopause.

At CONUS latitudes, the trope's altitude is generally around 37,000 to 40,000 feet. Closer to the equator, the trope reaches as high as 65,000 feet and settles to about 28,000 feet at the poles. Since tanker missions can be flown under, over, and through the tropopause, some unexpected temperature changes can occur.

When you anticipate flying through a jet stream, watch your Doppler, check your metro sheet, and compare all of your information. Your pressure pattern results may start out valid, then go bad for a time, and again become perfectly good.

So, the existence of a few variables shouldn't keep you from using pressure pattern by temperature. With good control of aircraft altitude, and with corrections for varying airspeed, pressure pattern can be an easy and reliable aid.

Captain Watters graduated from the Air Force Academy in 1970 with a major in aeronautical engineering. He graduated from UNT in 1971 with an assignment to the KC-135 aircraft, 509 AREFS at Pease AFB. Captain Watters presently is working towards a master's degree in Aeronautical Engineering at AFIT.

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Anyone can navigate

Lieutenant Colonel Thomas D. BANDLER, USAF, Ret

We had been shooting some stars just outside the Navigation School classroom in San Marcos, Texas. Well, that's not exactly right. *I* hadn't. But the other fellows had been looking through their A-10 sextants, a little gadget which makes stars visible to the naked eye, and neatly finding out through celestial navigation that we were standing just outside the Navigation School classroom in San Marcos, Texas.

But me, when I peered through the little glass opening of the sextant, all I could see was my own eye. No stars. No planets. No heavens even. Just my own eye.

Well, this wasn't too good. Not that it made much difference then for I felt pretty confident of our whereabouts at the time even without the sextant. But still and all it made a navigational career seem somewhat hazy. It didn't bode too well for the future. It seemed possible that sooner or later ten innocent B-17 crew members might be dependent upon the dubious sextant of one slightly helpless navigator. We might be over an ocean someday. We might be lots of places. We might not always be just outside the classroom in San Marcos, Texas.

So I resigned from Navigation School. It was the noblest thing to do. It was the safest thing to do.

But this was in early '43, a year when navigators were pretty scarce. The Air Force was reluctant to accept my resignation. No, they would get me a different sextant, an A-12, one a blind man could see through, one they trained seeing-eye dogs with. Which they did. And I could see. I graduated from Navigation School. I had my wings. I was a real navigator. *I was ready.*

And then they gave us our permanent equipment, the stuff we would keep forever, the stuff our lives depended on. And I got a sextant, all for me, a key to celestial navigating, the one which, it turned out, I kept all through my navigational career. The kind I couldn't see through!

And the point of this article is that I never did become a better navigator than I was that day. But, through a quantity of errors, I eventually became a lead navigator of the 8th Air Force. I got the Distinguished Flying Cross. And I got lost in England, France, Holland, Belgium, and Germany. And I was considered a hero. But I never could find my way in that airplane.

Well, soon after leaving San Marcos we were assigned to the Overseas Training Unit in Gulfport, Mississippi.

It was there that we first assembled into a complete B-17 crew, with which we theoretically would later go overseas and win the war. We flew long training flights daily, flights in a sort of follow the leader formation. There would be about 12 planes, with an experienced crew in the lead plane, and we followed the lead plane and tried to keep track of where he took us. This was also true in combat. You followed the lead plane and dropped bombs where he did. It seemed to me a highly satisfactory system, *as long as I wasn't in the lead plane!*

Anyhow, to sort of morphiate the boredom of our flights, we started listening to the commercial radio in our plane. This is an interesting gadget installed for various useful purposes, a by-product being that we could listen to local stations over wherever we were flying. For navigational purposes, it had a face like a clock and a single hand which pointed toward the station. In other words, if the ground station was ahead of you it would point north, or up, while if it were to your left, it would point left. Very simple. A child could figure it out. *I* could figure it out!

It was a good gadget, and the only thing was that it wouldn't work over oceans, over Germany, or, for that matter, over half the places in the U.S.A. It had a limited value. They told us, in fact, not to use it. It was the one navigational gimmick which, in the Army's opinion, was more or less worthless. It was the only one I could work.

From Gulfport to Memphis

Well, my crew was happily following the other 11 planes one merry morning when *the* incident occurred. We had been over clouds for about three hours, and, of course, I was lost.

Naturally this was no surprise, but it was a terrible surprise when the pilot called up in some excitement to announce that the other 11 planes were also lost, and where were we? To this day, and faster than I could say "just a minute," which I promptly did, I have wondered why he ever asked me. He must have known I wouldn't have any idea. He must have been nervous.

About two minutes later he called again. He was quite excited. Something about low on gas. The other planes wanted to know.

I felt no glow of opportunity, just my usual shame, and I repeated, "just a minute." In blind hope, however, I fiddled with the radio, my only

friend. Well, believe it or not, the thing suddenly started playing music very loudly and pointing straight ahead. This meant we were very close to somewhere. I felt better. I knew more than I ever had before. I was warm. We were near somewhere. I felt like Confucius. I watched the needle and it started turning left very quickly. We were almost abreast of somewhere. The only detail missing was where. Suddenly the music stopped and the announcer said: *"And next, as a tribute to the fighting men of Memphis, we will play their Victory March."*

Well, this changed the picture. No longer were we near somewhere. We were either right above the outskirts of Memphis or else we were near anywhere in the world that had a scheduled football game with Memphis.

I decided to take a chance.

I called the pilot: *"Glenn, don't tell anyone I said so, but if I had to guess I'd say we were just about a minute away from Memphis and that it was just on our left. But don't quote me to the other planes."*

Good old confident Glenn, however, immediately announced to the other planes that we would be over Memphis in exactly one minute, just on our left. I guess he figured that since you couldn't see the ground anyhow it was a safe announcement. I felt terrible. We had about zero chance. I'd resign again. My name would be mud.

But *darned* if in exactly one minute there wasn't a break in the clouds, just on our left; and *darned* if there wasn't a big beautiful city; and *darned* if the other navigators didn't recognize it as Memphis. I had no idea what it was, myself.

When we got home I was a hero. I was Balboa, Columbus, Joe DiMaggio. I could do no wrong. I was a real navigator. *I was famous* in our group.

So, from that time on, I never paid any attention to where we flew. *Why should I?* I was a hero. I knew everything. My crew trusted *me*. *I* could play the radio.

Enter the Log

They have a nasty thing in AAF circles called a log. This is a standard form on which is recorded the history of each flight. The navigator theoretically fills it in every few minutes, showing how fast he is flying, wind direction, where he is at that time, and what time he is expected to reach his destination. The expected time of arrival is abbreviated as ETA, and is the sixty-four dollar question of every navigator. A good navigator is expected not only to reach his destination, but to reach it fairly close to his ETA.

In my own case, I never really cared about ETAs, being always thankful when we arrived in the right place in the first place, but still and all they were good things and very important.

But about the log itself. The AAF certainly could have suffocated the Germans by dropping the wasted logs in Europe. We might have been without food, there were days when we lacked engines for our planes, but, by George, we always had plenty of logs. And the worst part, we were supposed to turn one in—complete in every detail—every time we left an airplane. They served as a check on the navigator.

In Navigation School it was easy. Three of us flew on every mission, one doing *pilotage* (looking at the ground), one *dead reckoning* (figuring it out from the log), and one celestial (the stars).

On these flights it was fairly easy to keep a log. The pilot knew where he was going and didn't have to bother you. And while two of the student navigators were usually lost, the good old *pilotage navigator* could usually manage to let you know where you were and you slipped that down on the log. Personally, when I was in that swaying plane, I couldn't work even the sextant I could see through. Yet I became very adept, upon being told where we were, at figuring the tables and putting the stars where they were supposed to be. I would then turn in my log. Although the methods for creating it were of no navigational value, the log looked okay—and I graduated from school.

All this time, of course, I was patiently trying to acquire a sextant I could see through. I don't know why, particularly, since the fact of the matter was that I couldn't work it anyhow, but I just felt a kind of personal grudge against the AAF for their snide ways. Every time we shifted closer to an overseas unit, I would rush to the supply officer, explain that I couldn't see through my A-10 sextant, and could I please have an A-12. The inevitable answer, *"the next base."* To this day I haven't reached that base.

Over Choppy Seas

When we finally took off for the flight over the Atlantic Ocean to Scotland, I still had the sextant I couldn't see through. It was in a nice wooden carrying case, and came in very handy as a chair. I never took it out of the box. This upset the crew somewhat, but I kept telling them about Memphis, and to my surprise we only missed the ETA into Scotland by two minutes—considerably better than par for the course.

Now, the average navigator thinks he's pretty smart. All right, maybe he isn't like me and he doesn't get lost in Central Park. So he flies along for a couple of hours following his flight plan, and he works his driftmeter or his sextant or his DR or his compass—anything but the radio—and he

figures, "Ah hah, the wind has changed, the flight plan is wrong. I shall have to improve on it." And sometimes he's right. The wind *does* change. The sextant can be right. And he may be right.

But *I* suffered no such handicaps. I didn't have a workable sextant. Confidence, the driftmeter, and I were not on speaking terms. And the radio didn't work over the ocean.

So, I did an ingenious thing. I followed the flight plan exactly. We might have been drowned, we might have landed in Germany; we might have disappeared—but we didn't. We only missed the ETA by two minutes. It was superb navigation. My crew will swear today that I was the world's best navigator. I didn't deny it then. It's good for your crew to have confidence in you. I was a hero. The only thing was, in spite of my wings, in spite of flying the ocean, in spite of my crew, I couldn't navigate worth a darn.

England was a grand country. I liked the land, the girls, the pubs, the girls, London, and the girls. They had a free and easy camaraderie. Maybe they only wanted to get married, to come to America, to have a candy bar, a piece of soap, a cigarette; but, anyhow, they were real and they tried to be nice. We weren't freeing their country, or saving it; they could do that themselves. We were a bunch of guys with a few bucks and a devil-may-care attitude. We represented fun and escape. I liked them.

From a navigational standpoint, however, England was an awful place. Densely populated, the countryside all looked the same from the air, and it was practically impossible to identify your position by pilotage. Everything looked the same. I was constantly being embarrassed.

Spelled Backwards—It's Still Radar

Along about this time we were exposed to radar. Radar is another clock-faced gadget on which land and cities appear as yellow, whereas water appears black. In other words, if you are flying over the coastline, you can identify it by its outline in yellow, and a city will show up as a bright yellow dot. This is all very well, if you are where you think you are in the first place and a dot shows up. You can announce: *"This is London."* But if you don't know where you are anyhow, one dot always looks pretty much like another dot, and when I proudly announced we were over some unknown dot, it aroused little enthusiasm among the crew.

Some of us were sent to a radar school. It was a fine assignment. It meant we could have two weeks leave in London before school started.

You may have guessed that I was kicked out of radar school. For a change I didn't have to resign. But the interesting thing was this. I wasn't kicked out for being unable to work the radar. I was kicked out for being unable to navigate. *Period!* For once everybody agreed. *I was a failure.* I was unable to do simple navigation over England. I felt terrible. I thought they would send me home.

Instead, they send me to a combat group and three days later I flew my first bombing mission over Germany.

Combat navigation in the 8th Air Force, I soon found out, had its advantages. You could drop bombs on the enemy. You could strike a blow for democracy. But who cares? These trivia were unimportant. The magnificent thing was, really, that in the 8th Air Force you didn't have to use the sextant. In fact, you didn't even have to navigate. All you had to do was follow the lead plane. Just like OTU. Follow the lead plane.

I had found my niche.

Combat sounded like fun.

On my first mission we bombed Aachen, a pleasant little town in the Ruhr Valley. By my standards, it was a highly successful mission. We hit the target and we got home safely. My navigation had been superb. I hadn't made a single mistake. I hadn't opened by mouth. I hadn't made an entry on my log. I had never known where we were. I had been lost the entire time. But we got home safely. The mission was successful. My crew had confidence in me. I had recognized the English Channel. We got home safely. We were in. We were Veterans. Navigation was easy. We were heroes.

In reviewing my Air Force career, it seems incredible that I ever became a lead navigator, the guy in front of those other 35 planes. I never wanted to be one. I knew I was the world's worst navigator. I knew that announcer in Memphis wouldn't show up over Berlin. I didn't like navigation. I didn't like airplanes. I couldn't understand what made them fly.

Still and all, everything went pretty smoothly for the next few missions. We would peacefully fly into formation and peacefully follow the guy ahead to Germany and back. Our plane was just like Mary's little lamb. It was a good arrangement. But on our seventh mission we ran into a little trouble. Our plane wouldn't work. It wouldn't leave the ground. It must have been psychic.

We felt pretty good about the whole thing. Our target that day was Merseberg, a place with more flak guns than anybody. It was a good day to stay home and play poker.

But the colonel felt differently about the matter. It seems they had extra planes for little emergencies of this kind. And he felt it would be nice if we could go along with the other fellows.

Firm Guidance

"Just intercept them along the coast," he said.

Well, this was really something. Our group had been gone thirty minutes by this time. And all the colonel wanted us to do was intercept them along a vague coastline in a foreign country at an indefinite altitude at an uncertain time in a plane flying 200 miles an hour.

The colonel's proposal made me laugh. It was practically an impossibility. Even a good navigator couldn't have done it.

I didn't even try. I just flew east and headed towards Germany. We tagged onto the first group of airplanes we could find in the sky. It turned out to be our own 8th Air Force. We breathed easier. We flew into position. It turned out to be our own group!

I told the crew it was luck. They wouldn't believe me. I told the colonel it was luck. He wouldn't believe me. Instead, they made me deputy lead navigator. I was again a hero.

On my first mission as deputy lead, everything had gone pretty smoothly. Our target was Berlin. We had found it. We were over it. We were about to drop our bombs. I might add that dropping the bombs was the high point of any mission. Not from a tactical standpoint. From a safety standpoint. Once you dropped your bombs you were much less of an explosive target. If a stray piece of flak hit the bomb bay, which was always likely, you wouldn't go up in a thousand pieces. You would just settle slowly, and maybe even have a chance to jump.

Well, there we were over Berlin and the bombs were about to be dropped. I was huddled over my flak suit, behind the bombardier, protected in two directions, patiently waiting to hear "bombs away." Then we would go home.

Finally I heard the magic words. The plane lightened. We started to turn towards home. I relaxed. I uncovered my eyes. I felt better.

The pilot screamed over the interphone, "Which way do we go?" What a dummy, I thought. "Follow the lead plane," I said. "It's just been shot down," he said. "Oh," I said. "Then follow the lead squadron." "We're the lead squadron," he said. I thought I could detect a certain impatience in his voice. We were still turning. I looked out the window. There was heavy flak to our left and heavier flak to our right. *"Straighten out,"* I said *"It's a short cut."*

I felt like a guy who has just climbed the ladder of success, burned it triumphantly behind, and then discovered he has to climb down again to find the bathroom. Only no ladder.

We *weren't* outside the classroom in San Marcos. I *couldn't* copy someone else's log. There *wasn't* any lead plane to follow. I *couldn't* even resign. I was over Berlin, Germany, 1,000 miles from home, and 34 airplanes were hanging on my vapor trails. The pilot wanted to know where to go. They were shooting at us. I was in the plane, too!

The day was gorgeous. You could see the countryside for miles and miles. The only thing was, it all looked the same to me. We flew straight. I quit looking at the ground. I looked in the air. Maybe, I thought, I can pick something out of it.

I did. In the distance, about 20° left, flying confidently as carrier pigeons, were two other groups of planes. I assumed they were ours. They were heading away from Berlin. *"Turn 20° left,"* I said. *"And step on the gas."*

We followed the groups over Germany, we got to the Baltic Sea, we disappeared from the sight of land. I relaxed. No flak. We were going home.

You must understand that although I was the world's most hopeless navigator I never mentioned this to the crew. It wouldn't have done any good and might even have worried them needlessly. I never said, *Follow that plane,"* just *"Twenty degrees left."*

Well, long about this time I started fiddling with the *gee box*. This is a navigational aid which tells you exactly where you are when it tells you anything at all. It works over England, it works over occupied France, it works like the radio, wherever they have stations. But they hadn't sold the Germans on the idea. It didn't work near Berlin.

But, by George, it worked then, and for the only time in my combat career I knew for sure where we were. The *gee box* said we were over the Baltic Sea. I checked again. I looked out the window. Water. No question about it. I made an entry in my log.

And then for no reason I can think of, the two groups ahead of us turned a sharp left and headed straight for occupied France.

Well, I can safely say, this was a problem. And not only mine. The pilot called me. He was a special pilot. He wasn't so dumb. *"Those other groups are turning left,"* he said, *"and I'm going to follow them."*

Ten minutes earlier I would have commended his intelligence. Two hours earlier we had cemented ourselves to their tails. We might have

been heading for Siberia. But we hadn't. We were over the Baltic Sea. And I knew it. *I was sure.* I would have bet my cigarette ration on it. I *couldn't* let him follow them. We would have been shot down.

"Listen," I said, *"We won't follow anybody. What kind of a navigator do you think I am?"* I was pretty hurt by his whole attitude. *"Just keep going straight!"*

He gave in. We watched the other groups disappear.

Tragically, to this day, I can't imagine where they went.

But *we* got home to England.

It was brilliant.

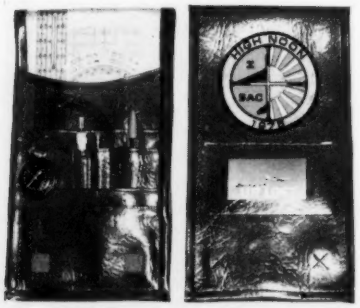
They promoted me to lead navigator.
And I was again considered a hero.
Do you think they *could* have been right?

Lieutenant Colonel Bandier retired from the Air Force in 1967 and then worked for Headquarters, Army and Air Force Exchange. In a recent conversation, Colonel Bandier said he so often got lost on the way to work that he finally quit in 1973. Since then, he has spent much of his time following the string to his favorite tennis court from his home in Dallas, Texas.

Major William E. BLUE
305 AREFW/DOTN
Grissom AFB, IN

On a flight from Hickam to the Canal Zone, you become temporarily disoriented. With fuel running low, you find an island on the radar scope. A heading is given to the pilot, a beach is spotted, and a good crash landing is accomplished on the beach. Now that everyone on board is safe, as the navigator you must determine which part of terra firma you have found. The stars are out so the problem should be easy. You have all your navigational equipment. The sextant averager is broken, but you can still take instantaneous shots. Through the clouds you find three bodies and make these observations.

GMT (1 Jan 78)	HO	
05h53m31s	35°50.1′	Menkar
06h04m10s	38°26.0′	Canopus
06h19m18s	42°18.2′	The brightest star in Leo or a planet.



Your signal fire is spotted by a local fisherman who offers to take the crew to an inhabited island. So, with your crew on board and the sails set, you fall asleep. Six hours later you are awakened by your host and deposited on a second island. It's shooting time again! You observe the sun at the appropriate time spacing to provide the best "cuts." At the following times you obtain these altitudes:

GMT (1 Jan 78)	SUN HO
15h03m41s	41°28.7′
18h02m15s	67°57.9′
21h07m38s	39°50.1′

What was your position after you crash landed and where are you now! Name the islands and the coordinates to the nearest nautical mile.

	Longitude	Latitude
Island 1	_____	_____
Island 2	_____	_____

Mail your answer to:

Editor, THE NAVIGATOR Magazine
323 FTW/DOTN
Mather AFB CA 95655

On 1 Oct 78, three names will be drawn from the lot of correct answers. The three winners will each receive a red naugahyde DR kit holder (see photo).

Editor's Note: The DR kits were furnished by the author, Major William E. Blue. Major Blue is the Chief, Wing Navigation Branch, 305th Air Refueling Wing, Grissom AFB, and is a previous contributor to THE NAVIGATOR.

NAVIGRAMS

UNT GRADUATING CLASS ADDRESS: Colonel Joe D. Bishop, a master navigator, Assistant Deputy Chief of Staff Comptroller for Aerospace Defense Command, recently addressed UNT graduating class 78-09. His discussion of the navigator career field included the following remarks:

> "...I believe one word covers what is expected of you after you leave Mather and that word is professionalism--both as an officer and as an aviator...The status of professionalism is not static--it continually moves and progresses--and if we aspire to be professional, we must also move and progress. This requires that we expand our professional knowledge. As an aviator, there will be new techniques and procedures, and we must stay abreast of them and use them. Additionally, we are expected to develop improved procedures and broadcast the improvements so that others may benefit."

USAF FIX IS RAF DR: So you think you've got problems! Did you know that a fix in the USAF is a DR in the RAF and vice versa? (RAF ⛰ is a DR; ⊙ is a fix.) That word comes to us from a somewhat confused RAF exchange officer.

CELESTIAL POSITIONING METHOD: Capt Leon Frantzick and 1st Lt Collin Flynn of the 343d Strategic Reconnaissance Squadron, Offutt AFB, suggest precomping for six minutes before MPP time and then moving the LOP(s) for groundspeed and track. The advantage of this technique is that you can resolve your position before MPP time while using an early, on-time, late shooting schedule.

AIR FORCE NOMINEE: Lt Luke Lu, 529th Bomb Squadron (SAC), Plattsburgh AFB, NY, is the 1977 nominee for the Institute of Navigation Superior Achievement Award. Lt Lu has amassed an enviable record since winning the Ira J. Husik Award for flying performance at UNT graduation in 1975. Lt Lu and his pilot have since won the Best Crew Award at the 1976 SAC Bombing Navigation Competition and achieved the best scores in several exercises and competitions.

DR IS THE BASIS OF ALL NAVIGATION: "According to popular definition, dead reckoning is short for 'deduced reckoning' or, as the old-timers used to say, 'you're dead if you don't reckon right.' In truth, however, the term originated with maritime navigation and refers to 'reckoning or reasoning (one's position) relative to something stationary or dead in the water.' Simply stated, DR navigation is a method of predicting en route progress based on the direction of flight and the estimated ground speed since the last known position." (Reprinted, with permission, from the AOPA Pilot, May 1978.)

Navigators at the FIGHTER WEAPONS CENTER

Captain Robert E. BURCH
TFWC/SAS
Nellis AFB, NV

With the formation of the Studies, Analysis and Gaming Deputate (DCS/SA) at the Tactical Fighter Weapons Center, new and challenging job opportunities became available for Weapon System Officers (WSOs) and Electronic Warfare Officers (EWOs).

DCS/SA was officially established at Nellis AFB, Nevada, in August 1975 in response to a TAC requirement for an agency to conduct continuous studies, analysis, and gaming of general purpose forces. This new TAC agency works closely with the Army's Combined Arms Center to assist in developing joint Army/Air Force requirements. These requirements are forwarded to TAC Headquarters for the Air Force, and to Training and Doctrine Command Headquarters for the Army, and could be forwarded to the Department of the Air Force and the Department of the Army for eventual presentation to Congress for approval and funding. The stated mission of Studies, Analysis and Gaming is "to provide information on major unilateral and joint issues which affect the size and mix of present and future general purpose forces; to provide studies and analyses estimates in support of major command positions; and to conduct joint analysis of projected weapons systems and technologies to assure an effective integrated fighting force."

To accomplish this challenging mission, DCS/SA must be manned by personnel from many specialties within the tactical air forces. People now assigned include experts in the fields of intelligence; operations and cost analysis; maintenance; computer programming; command, control and communications; and tactical air operations.

In tactical air operations, WSOs and EWOs have drawn extensively on operational experience and knowledge of tactical systems to provide significant contributions. DCS/SA's first study determined how the Army and Air Force could best employ their forces to suppress enemy air defenses. A major input to the study was the use and effectiveness of F-105G and F-4C Wild Weasel aircraft in a high threat environment. An EWO, experienced in both aircraft, was the keyman in supplying this vital information.

WSOs and EWOs routinely contribute to the various studies conducted at DCS/SA by providing data on targeting and weapons effects and the use and effectiveness of radar warning receivers and electronic countermeasure pods. They also supply data on friendly and enemy jamming capabilities and operational tactical procedures.

A unique opportunity also exists in the area of war gaming. DCS/SA is tasked to support the Army's Scenario Oriented Recurring Evaluation System (SCORES) war gaming efforts at Fort Leavenworth, Kansas. The joint efforts at Fort Leavenworth result in evaluations of the general purpose force packages, training, doctrine, and materiel necessary to support combat operations in any part of the world. DCS/SA contributes to these war games by providing tactical air (TACAIR) inputs for use in a close air support (CAS) environment. WSOs and EWOs act as both the Red and Blue Air Force Component Commanders. In these roles they provide information on using both friendly and enemy TACAIR assets and expected kill probabilities for weapons appropriate to a CAS situation.

"Fightergators" assigned to DCS/SA are able to increase their knowledge of both friendly and enemy tactical systems since many studies evaluate concepts and hardware which may be operational as far in the future as 1985. An example is a study currently underway to

determine the Advanced Wild Weasel (F-4G) tactics and procedures for the 1982 time frame. In addition to the F-4G, this study will also address the possible contributions to the Wild Weasel mission of proposed weapon systems such as the High Speed Anti-Radiation Missile and the Imaging Infrared Maverick.

While Nellis AFB is known worldwide as the "Home of the Fighter Pilot," the use of WSOs and EWOs in all aspects of operations at Nellis—from the Fighter Weapons Center to the Fighter Weapons School to the Range Group and to Red Flag operations—is showing that, even in the world of the fighter pilot, it takes teamwork to provide an effective and efficient tactical fighter force.

Commissioned through ROTC, Captain Burch completed UNT and EWO school in 1969. Assigned to the F-4, he served at George AFB, Ubon RTAFB, Thailand, and then RAF Bentwaters. B-52 assignments at Castle AFB and March AFB were followed by EWO duty at Osan AB, Korea. Since 1976, Captain Burch has been assigned to Nellis AFB as Analytical Studies Officer, Electronic Warfare.

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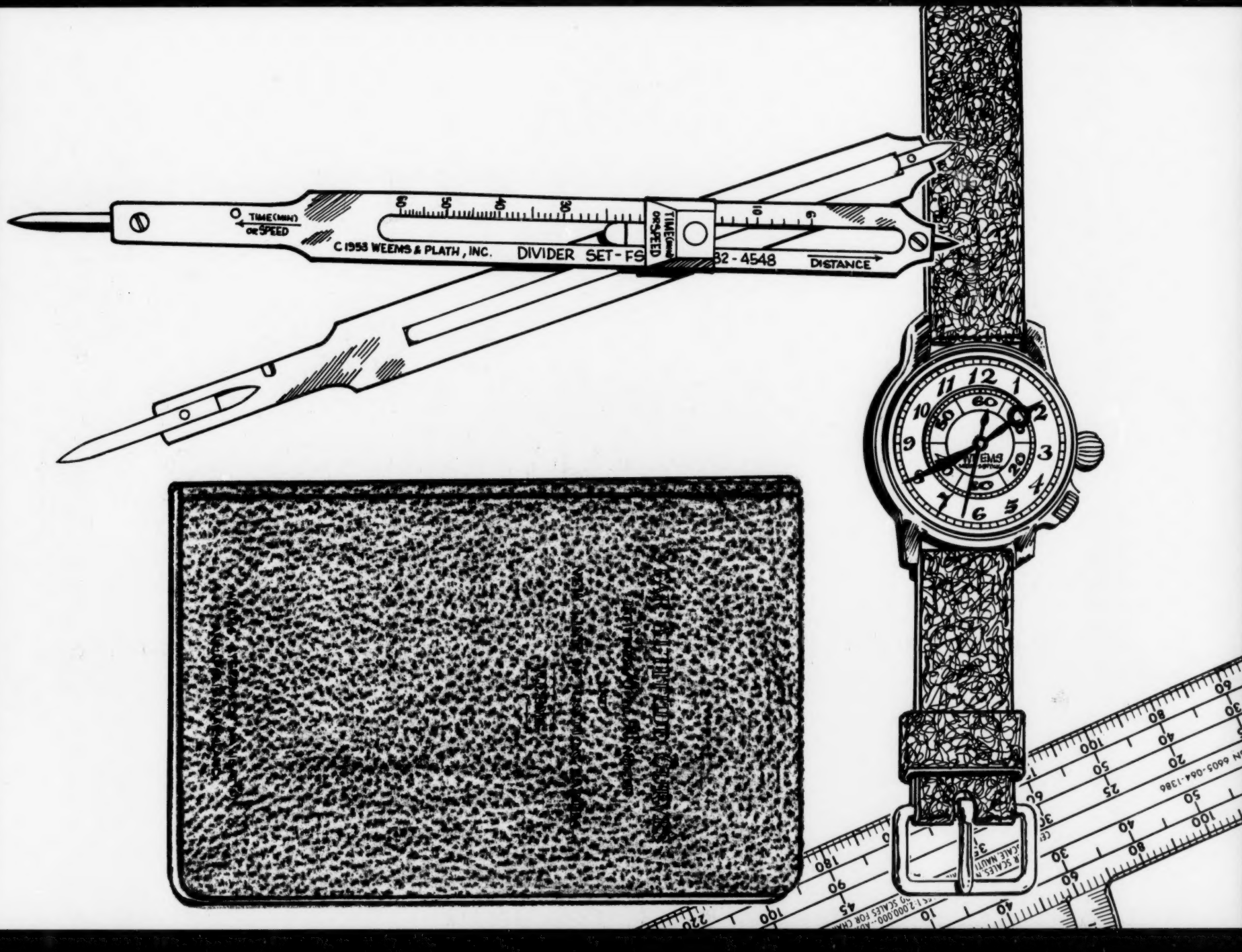
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